DRAFT

Draft Integrated Feasibility Report & Environmental Assessment

Rahway River Basin, New Jersey Coastal Storm Risk Management Feasibility Study

May 2017

New Jersey Department of Environmental Protection

U.S. Army Corps of Engineers New York District

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EXECUTIVE SUMMARY

This Draft Integrated Feasibility Report and Environmental Assessment is for the Rahway River Basin, New Jersey, Coastal Storm Risk Management Feasibility Study. The Rahway River Basin is located in northeastern New Jersey. It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The roughly crescent shaped basin is 83.3 square miles (53,300 acres) in area.

The Rahway River system consists of the Rahway River and four branches. The West Branch flows south from West Orange through South Mountain Reservation and downtown Millburn. The East Branch also originates in West Orange and Montclair and travels through South Orange and Maplewood. These two branches converge near Route 78 in Springfield to form the mainstem of the Rahway River. The Rahway River flows through the municipalities of Springfield, Union, Cranford and Clark before traveling through the City of Rahway. The Rahway River receives the waters of Robinson's Branch and the South Branch in the City of Rahway before it enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill, which connects Newark Bay with the Raritan and Lower Bays of the New York and New Jersey Harbor.

Project Area

The focus of this coastal storm risk management study is the area within the Rahway River Basin affected by coastal storm surge. The map below displays the 500 year coastal storm surge floodplain that is the focus of this study and denotes the study area (Figure 1).

Problem

The primary problem encountered in the study area is flooding from elevated water levels associated with coastal storm surge on the Rahway River and tributaries within the study area.

Storm Events

A number of storms, tropical storms, northeasters and hurricanes have caused coastal storm surge inundation and damage in recent decades. The most significant to this study are Hurricane Sandy & Tropical Storm Irene.

Hurricane Sandy: 22 – 29 October 2012

Hurricane Sandy initially formed as a tropical depression in the southwestern Caribbean. Sandy weakened somewhat and then made landfall as a post-tropical cyclone near Brigantine, New Jersey with 70-kt maximum sustained winds. Because of its extensive size Sandy drove a very severe storm surge into the New Jersey and New York coastlines.

As storm surge from Sandy was pushed into New York and Raritan Bays, seawater surge occurred within the Hudson River and the coastal waterways and wetlands of northeastern New Jersey,

including Newark Bay, the Passaic and Hackensack Rivers, Kill Van Kull, and Arthur Kill. Significant inundations occurred along the Hudson River in Weehawken, Hoboken, and Jersey City, where many high-water marks indicated that inundations were between 4 and 6.5 ft above ground level. Inundations of 4 to 6 ft were also measured across Newark Bay in Elizabeth and the area around Newark Liberty International Airport.

Conversations between the Corps and the Middlesex Office of Emergency Management (OEM) revealed that municipalities within the lower portion of the Rahway River Basin and general area suffered coastal storm surge induced flood damages from Sandy. It is estimated that Hurricane Sandy caused tens of millions of dollars of damage in the study area. The City of Rahway sustained an estimated $35 million in damages with approximately $15 million of it to city property and another $20 million to private property. Damages included costly repairs to the existing Corps levee pump stations. Damages for the Borough of Carteret are estimated at $53.1M. Woodbridge Township suffered damages estimate at $7M with 200 structures damaged, including 40 destroyed. The PSE&G power plant in Woodbridge was destroyed. Blue Acres at the NJDEP is in the process of buying out 175 structures in the township.

During Hurricane Sandy, bulk fuel tanks were damaged and fuel flowed into the Arthur Kill. The storm temporarily shut down oil refineries in the study area leading to shortages of fuel in northern New Jersey. No deaths linked with Hurricane Sandy have been identified within the study area.

Tropical Cyclone Irene: Storm of 27-28 August 2011

Irene made its United States landfall near Little Egg Inlet, New Jersey on Sunday, August 28, 2011 as a hurricane with maximum sustained winds of 75 mph. At this point Irene had weakened to a tropical storm. Tropical Storm Irene produced about three to 13 inches of rain on the watersheds within the New York District's civil works boundaries in northern New Jersey and southern New York in about a 16 hour period between Saturday, August 27 and Sunday, August 28. Tropical Storm Irene rainfall total for the Rahway River basin was about 10 inches. Irene generated a storm surge of 4 to 6 feet along the New Jersey coast and a surge of 3 to 6 feet in the New York City and Long Island areas.

Opportunity

There are opportunities in the portion of the Rahway River Basin affected by coastal storm surge to:

- Decrease risk of damages to structures and roadways due to flooding from coastal storm surge.
- Reduce risks to life and public safety due to flooding from coastal storm surge.
- Improve public awareness of coastal storm risks.
- Develop a coastal storm risk management plan that complements regional economic development planning.

Opportunities exist for the development of feasibility-level plans for the study area, which could complement and enhance regional plans for economic development. The NJDEP and the City of Rahway have indicated a desire for coastal storm risk management.

This Feasibility Study plan formulation considered a range of nonstructural and structural measures to reduce the risk of storm damage in the study area. Through an iterative planning process, potential coastal storm risk management measures were identified, evaluated, and screened. Those remaining were developed into numbered flood risk management alternatives. Based on an evaluation of the costs and benefits of the alternatives, including potential environmental impacts, a plan was identified as the Tentatively Selected Plan (TSP).

Study goals and objectives were developed to comply with the study authority and to respond to study area problems. Planning objectives were identified based on the problems, needs and opportunities as well as existing physical and environmental conditions present in the study area. The main goal is Contribute to National Economic Development (NED) by reducing the risk of flood damages caused by coastal storm surge within the study area, consistent with the nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. The main Federal objective is to reduce the risk of flooding damages caused by coastal storm surge within the project area, lying within portions of the municipalities of Carteret, Linden, Rahway and Woodbridge. Recommended plans should avoid, minimize, and then mitigate, if necessary, adverse project impacts to the environment. They should also avoid adverse social impacts and meet local preferences to the fullest extent possible.

The goals and objectives of this study are:

Goals

- Contribute to National Economic Development (NED) by reducing the risk of coastal storm surge flooding damage.
- Reduce the risks to life safety within the study area.
- Provide a plan that is compatible with future coastal storm risk management and economic development opportunities.
- Where possible coastal flood risk management alternatives should benefit environmental resources.

Objectives

- Reduce the risk of damages to property and dangers to life safety resulting from coastal storm surge flooding within the project area, lying within portions of the municipalities of Carteret, Linden, Rahway and Woodbridge.
- Increase public awareness to the risk of flooding from the Rahway River.

Constraints and Considerations

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. Further, plan formulation must provide safe conditions in the interest of public safety and be socially acceptable to the community. Planning constraints considered to this point are as follows:

Universal Constraints

- **Flood Heights:** Avoid or minimize inducing additional flood damages to any areas beyond the limits of the Coastal Storm Risk Management Project (ER 1165-2-26).

- **Environmental and Cultural Resources:** Alternatives should be designed to avoid or minimize negative impacts to these resources, to the maximum extent practical.

Study Specific Constraints

- **Navigation Channel:** The Arthur Kill contains a navigation channel for large ships that would preclude implementation of structural measures in the Arthur Kill itself.

- **Industrialized Shoreline:** The shoreline and area directly inland of the Arthur Kill are highly industrialized and no room exists for structural measures.

- **Green Acres:** Lower Essex Street Riverfront Park located in the City of Rahway, the Hawk Rise Sanctuary located in the City of Linden, and the Joseph Medwick Memorial Park located in the Borough of Carteret were acquired with Green Acres Program funds for recreation and conservation purposes. These properties are encumbered to permanently remain in use for recreation and conservation purposes. Plan formulation will avoid these areas to the extent practicable and minimize and mitigate for any project impacts in compliance with the New Jersey Green Acres Program regulations.

Considerations

- **Cultural Resources:** There are existing previously identified National Register of Historic Places (NRHP) listed or eligible historic properties within the study area. Impacts to these resources must be taken into consideration when formulating alternatives with the understanding that additional investigations must be carried out following selection of an alternative to determine the presence or absence of previously unidentified historic properties and archaeological sites within the project area. A Programmatic Agreement will be prepared to identify mitigation for adverse impacts, in consultation with the New Jersey Historic Preservation Office and other interested parties.

- **HTRW:** The chemical facilities and petroleum refineries along the right and left banks of the Rahway River in Carteret and Linden in the vicinity of the Arthur Kill are active and have ongoing HTRW issues that would make implementation of a structural solution difficult along the Arthur Kill and Rahway River in that direct vicinity.
- **Models:** The District will coordinate with the relevant Center of Expertise (PCX) on the use of certified models. As stated in Section 10.3, the District will use ecological models that have already been approved or certified for use by the Corps Ecosystem Restoration Center of Expertise (ECO-PCX) to quantify impacts.

TENTATIVELY SELECTED PLAN FEATURES

After considering a number of coastal storm risk management measures and screening those measures, the following alternative plans were developed and analyzed in detail.

- No Action (Without Project)
- Alternative #1: Levees and Floodwalls
- Alternative #2: Surge Barrier
- Alternative #3a & 3b: Nonstructural Measures + Barriers
- Alternative #4 & 4a: Levee Segment D + Nonstructural Measures

Among these alternatives, the TSP has been identified as Alternative 4a: 10% annual chance exceedance (ACE) Non-Structural Plan + Levee, No Ringwalls. Alternative #4a consists of nonstructural measures within the 10% ACE floodplain nonstructural plan and a levee (Alternative #1 Segment D Levee).

Alternative #4a consists of nonstructural treatment for approximately 136 structures (125 residential, 11 non-residential) of the 577 structures (211 residential, 366 non-residential) contained in the 10% ACE (10-yr) floodplain. Nonstructural measures were designed to the future conditions 1% ACE (100-yr) water surface elevation (WSE) plus one foot to account for water surface perturbations. No treatment is recommended at this time for the remaining 441 structures within the floodplain.

The Segment D Levee is 3,360 ft. long with a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft. The design height of the levee was evaluated at elevation 12.6 ft. North American Vertical Datum, 1988 (NAVD ’88), consistent with the existing levees in the City of Rahway. The levee is located next to the right bank of the Rahway River, approximately 1.2 miles downstream of the confluence with the South Branch. The upstream end is located at the industrial/commercial area by Ardemore Ave., continuing downstream to Dorothy St. Nonstructural recommendations on the protected side of this levee were omitted.

Optimization of Alternative #4a is the next step of the hydraulic analysis, during which nonstructural treatments and the levee segment will be revisited for analysis at various flood frequency design heights. Revisions and optimization[1] of the TSP will take place prior to release of the final report. Figure 1 below illustrates the project areas where the TSP elements are located.

In reducing damages from future events, the TSP contributes to National Economic Development. National Environmental Restoration considerations are addressed in Chapter 6 (Environmental Effects) of this report. As for Other Social Effects (OSE), the project would maintain the viability of routes of transportation, including emergency and other vital services in the 1% ACE floodplain behind the Segment D levee. Implementation of the project could induce Regional Economic

[1] Optimization determines the scale of the TSP that provides the greatest economic net benefits in terms of flood risk management. This would involve formulating different TSP sizes and analyzing those plans. The version of the plan where net benefits are maximized would become the plan recommended for implementation, if warranted.

Development (RED) benefis in the area as residents and business owners may be able to allocate resources and spending on other goods and services than repairing and replacing structures or goods damaged by flooding.

Residual risks associated with the TSP includes remaining average annual damages of $13,138,300 out of a total average annual damage pool of $17,526,500. The average annual damage pool is for the 0.2% ACE (500 yr) floodplain and this residual damage pool includes expected average annual damages to structures and other infrastructure associated with the chemical and petroleum facilities. Critical infrastructure in the remainder of the project area would not be significantly affected from the TSP as nonstructural measures would not alter the floodplain. Figure 23 illustrates the critical infrastructure overlaid on an aerial view of the project area.

The various mitigation measures being considered to avoid, minimize, reduce or compensate for the adverse environmental impacts expected from implementation of the proposed action are summarized in Table 1.

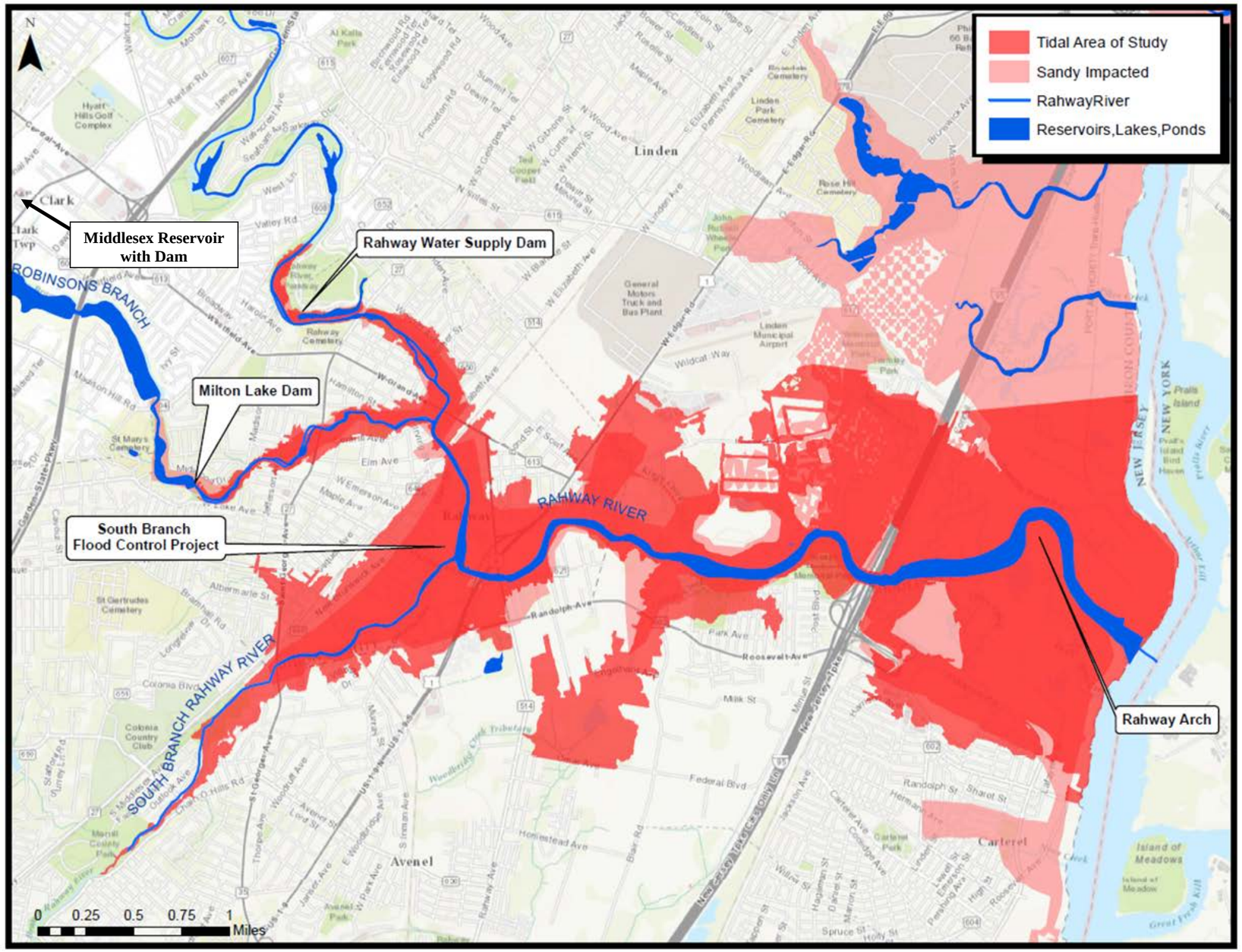

Figure 1. Project Area

Table 1: Summary of Mitigation Measures Land Use
• Disturbed areas will be restored and their use returned to pre-construction land uses.
Soils • Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of a cofferdam or temporary culvert diversion to install the levee drainage structure in Casey's Creek and to construct the levee over Casey's Creek.
Water Resources • Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of a cofferdam or temporary culvert diversion to install the levee drainage structure in Casey's Cree and to construct the levee over Casey's Creek. • Restoration of 200 linear feet of tidal creek. • Restoration of 0.14 acres of mudflat habitat. • Maintaining an open flap gate on the levee drainage structure in Casey's Creek during normal flows.

Wetlands
• Implementation of Erosion and Sediment Control BMPs including the use of wetland access/anti-tracking mats.
• Compensation of a total 5 acres of wetland habitat through:
  • Restoration of 4 acres of low marsh habitat.
  • Restoration of 0.50 acres of deciduous scrub shrub wetland.
  • Restoration of 0.40 acres of either deciduous scrub shrub wetland or low marsh (compensation for managed wetland impact).
• Restoration of 0.77 acres of low marsh wetland habitat subject to temporary impacts during construction.

Vegetation • Compensation of 0.70 acres of upland vegetation through either 1:1 creation/restoration or forest enhancement of areas that have been damaged through herbivory. • Use of more mature tree stock (8-14 ft high) to reduce maturation time.
Aquatic Resources and Wildlife • Tree and shrub clearing restriction from 1 April through 31 August to comply with the Migratory Bird Treaty Act. • Re-establishment of native herbaceous, shrub and tree species in disturbed areas and in mitigation sites. • Restoration of 200 linear feet of tidal creek. • Restoration of 0.14 acres of mudflat habitat. • Restoration of 4 acres of low marsh wetland habitat. • Restoration of 0.50 acres of deciduous scrub shrub habitat. • Creation/enhancement of 0.70 acres of upland forest habitat.
Federal and State Endangered, Threatened and Special Concern Species • Implementation of a tree clearing restriction from 1 April through 30 September to protect roosting bat species.

• Including tree species used by bats for summer roosting in mitigation plans.
Cultural Resources • The project is expected to have an adverse impact on historic properties, however, additional investigation is required to determine what properties will be impacted. A Programmatic Agreement has been developed for the project that outlines the steps that will be taken to determine adverse effects and the appropriate mitigation measures in consultation with interested parties (see Appendix A). Some mitigation measures to be considered include HABS/HAER documentation of historic structures, archaeological data collection, replacing or providing substitute resources, monitoring during construction, and enhancement of historic districts through signage and public outreach.
Recreation • Planting native herbaceous, shrubs and trees within the Joseph Medwick Memorial Park after construction. • Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians • Installing signage that informs residents and others using the effected recreational spaces of the proposed actions purpose and closure duration. • Installing a footpath on top of the levee. • Replacing the existing wildlife observation deck following construction of the levee.
Aesthetics and Scenic Resources • Replanting disturbed areas with native herbaceous, shrub and tree material after construction.
Transportation • Preparation of a Construction Traffic Management Plan. • Routing and scheduling construction vehicles to minimize conflicts with other traffic • Strategically locating localized staging areas to minimize traffic impacts; and • Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.
Air Quality • Because the air emissions are below de minimis levels for NOx, VOC, PM2.5 and SO2, no specific mitigation is required. Construction will be performed in compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34).
Noise • Construction will occur within the timeframes allowed as per local noise ordinances.

The non-Federal project partner for the study is the New Jersey Department of Environmental Protection (NJDEP). Although a non-Federal sponsor for project implementation has not been formally identified at this point in the study, it is anticipated that the NJDEP would sign a Project Partnership Agreement (PPA) and serve as the non-Federal sponsor for project implementation at a 65% Federal and 35% non-Federal cost-share.

PERTINENT DATA

TENTATIVELY SELECTED PLAN FEATURES

The TSP consists of the following elements.

- Levee Segment D is 3,360 ft long with a 12 ft top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft. The levee is located next to the right bank of the Rahway River, approximately 1.2 mile downstream of the confluence with the South Branch. The upstream end is located at the industrial/commercial area by Ardemore Ave., continuing downstream to Dorothy St.
- In addition to those structures that Levee Segment D provides flood risk management to, approximately 136 structures within the 10% ACE floodplain will be treated with nonstructural measures to manage flood risk to the 1% storm event plus one foot.
- The number of structures receiving nonstructural treatment and the size of Levee Segment D may change as the plan is optimized. The nonstructural measures will decrease risk to life safety by elevating structures and those within them above 1% ACE flood levels. Levee Segment D will reduce risk to life safety to areas behind the levee during storm events. In this area, local roads will have a greater likelihood of remaining passable to emergency vehicles and services.

Revisions and optimization[2] of the TSP will take place prior to finalization of the report. Figure 1 below illustrates the project areas where the TSP elemements are located.

Construction Method: Initial construction of the Segment D levee is estimated to take from October 2019 until September 2021. Initial construction of the nonstructural measures are estimated to take place within that time frame. Construction years are assumed for the economics evaluation in this study, but are subject to report approval scheduled December 2018, acquisition of necessary real estate, project approval and funding requirements, including Federal and non-Federal funds.

Real Estate Requirements. USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. Details are provided in Appendix E (Real Estate Plan).

[2] Optimization determines the scale of the TSP that provides the greatest economic net benefits in terms of flood risk management. This would involve formulating different TSP sizes and analyzing those plans. The version of the plan where net benefits are maximized would become the plan recommended for implementation, if warranted.

PROJECT COST

Project costs were developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) program. The MII cost estimate used RSMeans, MII Cost Libraries, and vendor quotations. The project contingencies were developed through the Abbreviated Risk Analysis (ARA) tool provided by the USACE Mandatory Center of Expertise. The summary of the results of this risk analysis, and more detail on the cost estimate, can be viewed in Appendix D (Cost Engineering).

The project cost estimate is broken out by cost component in Table 2. This includes planning, engineering and design, construction management, interest during construction and operation and maintenance (contingencies are included).

Project First Cost is the constant dollar cost of the TSP at current price level and is the cost used in the authorizing document for a project. Total Project Cost is the constant dollar cost fully funded with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in Project Partnership Agreements for implementation of design and construction of a project. Total Project Cost is the cost estimate provided to non-Federal sponsors for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation. The TSP First Cost is $66,900,000 and the TSP Total Project Cost is $70,930,000.

Table 2. TSP Refined Cost Estimate*

(October 2016 Price Level, FY17 2.875% discount rate, Rounded to nearest 1,000)

Account/Cost Component	**TSP First Cost (Alternative 4a)**	**TSP Total Project Cost (Alternative 4a)**
Total Project Cost		
01 – Lands and Damages	$2,192,000	$2,324,000
06 – Fish & Wildlife Facilities	$1,914,000	$2,030,000
11 – Levees & Floodwalls	$10,297,000	$10,919,000
18 – Cultural Resource Preservation	$3,321,000	$3,522,000
19 – Buildings, Grounds & Utilities	$32,989,000	$34,982,000
30 – Planning, Engineering & Design	$11,668,000	$12,084,000
31 – Construction Management	$4,519,000	$5,069,000
Estimated Total Project Cost	**$66,900,000**	**$70,930,000**

*Note: These costs will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

Operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of requirements after receipt of the project. This consists of periodic project inspection and maintenance. The OMRR&R cost is estimated at $51,484/year.

ECONOMIC ANALYSIS

The Costs and Benefits of the TSP are provided in Table 3. Projects costs are annualized over a 50-year period of analysis at the Fiscal Year 2017 (FY17) Federal interest rate for evaluation water resource projects (2.875%). Dividing the annual benefit of the project by the annual cost estimate results in an estimated Benefit-Cost Ratio of 1.7.

Table 3. Refined TSP, Annual Benefit and Cost Summary*
(October 2016 Price Level, FY17 2.875% discount rate)

	TSP
First Cost	$66,900,321
Interest During Construction	$1,598,186
Total Investment Cost	$68,498,507
Annual Investment Cost	$2,599,387
Annual O&M	$51,484
Annual Cost	$2,650,871
Annual Without Project Damages	$17,526,500
Annual With Project Damages	$13,138,400
Annual Benefits	$4,388,100
Net Benefits	$1,737,229
Benefit Cost Ratio	1.7

*Note: The Benefit-Cost Ratio will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

FEDERAL AND NON-FEDERAL PROJECT COST SHARING

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65% Federal and 35% non-Federal. The estimated Total Project Cost is $70,930,000, cost-shared $46,104,000 Federal and $24,825,000 non-Federal.

Table 4. First Cost Apportionment Table

	Federal	**Non-Federal**	**Total**
Initial Project Cost	$43,485,209	$23,415,112	$66,900,321
Real Estate Credit		$2,717,219	
Cash Contribution		$20,697,893	
Total	$43,485,209	$23,415,112	$66,900,321

Table 5. Total Project Cost Apportionment Table

	Federal	Non-Federal	Total
Initial Project Cost	$46,104,000	$24,825,000	$70,930,000
Real Estate Credit		$2,717,219	
Cash Contribution		$22,107,781	
Total	$46,104,000	$24,825,000	$70,930,000

The non-Federal sponsor is responsible for providing all lands, easements and rights-of-way as part of their portion of the cost-share, in this case estimated at $2,717,219. This can be seen in Table 5 and in combination with the $22,107,781, make up the non-Federal portion of a total of $24,825,000. Further information on real estate can be found in Appendix E – Real Estate Plan.

Rahway River Basin, New Jersey
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**Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements*

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LIST OF ACRONYMS

Acronym	Title
AAB	Average Annual Benefits
AAC	Average Annual Costs
AAD	Average Annual Damages
ACE	Annual Chance Exceedance
AEP	Annual Exceedance Probability
AMNET	Ambient Biomonitoring Network
APE	Area of Potential Effect
ARA	Abbreviated Risk Analysis
BCR	Benefit Cost Ratio
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CEQ	Council of Environmental Quality
CSRM	Coastal Storm Risk Management
CZM	Coastal Zone Management
DIFR/EA	Draft Integrated Feasibility Report and Environmental Assessment
District	United States Army Corps of Engineers, New York District
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ETL	Engineering Technical Letter
FHACA	Flood Hazard Area Control Act
HTRW	Hazardous, Toxic and Radioactive Waste
IBA	Important Bird Area
KCS	Known Contaminated Site
LERRDs	Lands, Easements, Rights of Way, Relocations and Disposal/Borrow Areas
LIDAR	Light Detection and Ranging
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher High Water
MCACES	Micro-Computer Aided Cost Estimating System
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MTL	Mean Tide Level
NAAQS	National Ambient Air Quality Standards
NACCS	North Atlantic Coast Comprehensive Study
NAVD	North Atlantic Vertical Datum (1988)
NED	National Economic Development
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum (1929)
N.J.A.C	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDEP BFBM	New Jersey Department of Environmental Protection, Bureau of Freshwater and Biological Monitoring

NJDEP DLUR	New Jersey Department of Environmental Protection, Division of Land Use Regulation
NJDEP DFW	New Jersey Division of Fish and Wildlife
NJSHPO	New Jersey Historic Preservation Office
NOAA-NMFS	National Oceanic and Atmospheric Administration – National Marine Fisheries Service
NOS	National Ocean Service
NPL	National Priority List
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OEM	Office of Emergency Management
OSE	Other Social Effects
P&G	Principles & Guidelines
PM	Particulate Matter
RED	Regional Economic Development
SLC	Sea Level Change
TSP	Tentatively Selected Plan
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WSE	Water Surface Elevation

Chapter 1.0 Introduction

1.1 Draft Integrated Feasibility Report and Environmental Assessment

The U.S. Army Corps of Engineers (USACE), New York District (District), and the non-Federal sponsor, the NJDEP, prepared this Draft Integrated Feasibility Report and Environmental Assessment (DIFR/EA) for the Rahway River Basin, New Jersey, Coastal Storm Risk Management Feasibility Study. This report presents the Tentatively Selected Plan (TSP) for managing coastal storm risk within the Rahway River Basin, New Jersey. The Rahway River Basin is located in portions of Essex, Middlesex and Union Counties. Over the course of the review process, the report will be updated to include input from the NJDEP, as well as local governments, resource agencies, and the public.

The Federal objective of water and related land resources project planning is to contribute to national economic development (NED) consistent with managing and reducing risk to the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (Principles and Guidelines (P&G), 1983).

Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. Pursuant to this, the DIFR/EA (1) summarizes the problems, needs, and opportunities for coastal storm risk management in the Rahway River Basin; (2) presents and discusses the results of the plan formulation for coastal storm risk management; (3) identifies specific details of the Tentatively Selected Plan, including inherent risks; (4) and will be used to assist in determining the extent of the Federal interest and local support for the plan.

This DIFR/EA is being released for concurrent public and agency technical review. USACE has evaluated an array of structural and nonstructural alternatives including levees, floodwalls, surge barriers, ringwalls, structure elevation and flood proofing for the identification of the TSP. The TSP will be refined based on comments from public and agency review. It will contain additional feasibility level optimization for the Final Integrated Feasibility Report and environmental analysis conducted for and presented in the Environmental Assessment (EA).

1.2 National Environmental Policy Act Requirements

This Draft Integrated Feasibility Report and Environmental Assessment (DIFR/EA) was prepared pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's (CEQ) Guidance Regarding NEPA Regulations, and the USACE's Procedures for Implementing NEPA (Engineering Regulation [ER]-200-2-2).

NEPA requires the USACE to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Federal regulations to implement NEPA are found

in Title 40 Code of Federal Regulations (CFR) Parts 1500-1508. The intent of NEPA is to ensure that information is made available to public officials and citizens about major actions taken by Federal agencies, and to identify and consider public concerns and issues. "*Any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork*" (40 CFR §1506.4). This draft report integrates discussions into the feasibility report that normally would appear in a Final Environmental Assessment (FEA) in the feasibility report. The purpose of an EA is to aid a Federal agency's compliance with NEPA.

This DIFR/EA must discuss:

- the need for the proposed action;
- the proposed action and alternatives;
- the probable environmental impacts of the proposed action and alternatives;
- and the agencies and persons consulted during preparation of the DIFR/EA.

This integrated report is consistent with NEPA statutory requirements. The report reflects an integrated planning process, which avoids, minimizes, and mitigates adverse project effects associated with coastal storm risk management actions. Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements.

1.3 Study Purpose

The purpose of the study is to determine if there is a technically feasible, economically justified and environmentally acceptable recommendation for Federal participation in coastal storm risk management for the Rahway River Basin study area in New Jersey. The study will evaluate potential solutions to the frequent coastal storm surge flooding problems within the Rahway River Basin and assess the Federal interest in participating in coastal risk management plans. If warranted, the study will identify and recommend a plan in coordination with the NJDEP. The Feasibility Report is intended to constitute a final response to the study authority.

1.4 Study Authority

The study was authorized in a resolution of the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The Rahway River Basin resolution was dated 24 March 1998.

"*Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army review the report of the Chief of Engineers on the Rahway River, New Jersey, published as House Document 67, 89th Congress, and other pertinent reports to determine whether any modifications of the recommendations contained therein are advisable at the present time, in the interest of water resources development, including flood control, environmental restoration and protection and other related purposes.*"

Additional Study Guidelines. The Disaster Relief Appropriations Act of 2013 was passed by Congress and signed into law by the President on January 29, 2013 as Public Law 113-

2 (Act). The legislation provides supplemental appropriations to address damages caused by Hurricane Sandy and to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities, and reduce the economic costs and risks associated with large-scale flood and storm events. Hurricane Sandy was a catastrophic storm that struck the Atlantic coastline in late October 2012, resulting in loss of life, severe damage to the coastline, widespread power outages, and damage to infrastructure, businesses and private residences. The storm also resulted in degraded coastal features, which has increased the risks of and vulnerability to future storms. Expected changes in sea level rise, an increased probability of extreme weather events, and other impacts of climate change are likely to increase those risks even further.

Based on the Disaster Relief Appropriations Act of 2013, this coastal storm risk management study in the Rahway River Basin was initiated by separating coastal storm risk management from the existing and ongoing fluvial flood risk management study for the Rahway River Basin, New Jersey. The Corps has determined that fluvial and coastal storm surge flooding are distinct from one another.

1.5 Non-Federal Sponsor

The Federal government and Non-Federal sponsor(s) share responsibilities for project planning phases. Through the Disaster Relief Appropriations Act of 2013 Federal funds were provided for the current Feasibility Study for the study area. The cost of the Feasibility Study phase is 100% funded by the Federal government. A Feasibility Cost Sharing Agreement (FCSA) was executed in October 2014 with the New Jersey Department of Environmental Protection (NJDEP) as the non-Federal sponsor.

1.6 Prior Studies, Reports, and Existing Water Projects

Many USACE reports have been produced for the Rahway River Basin. The reconnaissance report listed below was most significant with regard to the evolution of this study and its focus on coastal storm surge flooding.

Section 905(b) Reconnaissance Study, Rahway & Woodbridge River Basins, July 1999

The purpose of the 905(b) Reconnaissance Study was to determine if Federal interest for flood risk management existed in the Rahway River Basin, beyond the geographic scope evaluated for the Robinson's Branch GRR. The Draft Reconnaissance Report summarized eleven prior reports completed within the basin since 1962. Two potential projects with positive benefit-cost ratios (BCRs) were also identified in the Draft Reconnaissance Study. The first project was a system of levees, floodwalls, channel modifications, and interior drainage improvements along the Robinson's Branch, previously documented in the GRR referenced above. The second project located along the South Branch in the Township of Woodbridge, entailed regrading the parking lot of a shopping center as an overland flow route. The shopping center has since been replaced by a new commercial development with flood proofing; therefore, this project did not advance to construction due to lack of sufficient damages in the project area necessary for economic justification of the project.

The reconnaissance report is significant as is led to initiation of the Rahway River Basin, New Jersey, Flood Risk Management Feasibility Study. Following Hurricane Sandy in

October 2012, and the passage of Disaster Relief Appropriations Act of 2013, this separate study focusing on coastal storm surge flooding in the Rahway River Basin was initiated by separating coastal storm risk management from the existing and ongoing fluvial flood risk management study.

Federal Projects. A system of levees and pump stations for flood risk management was constructed by USACE in 1974 within the City of Rahway, New Jersey. The project area is located along the right (west) bank of the Rahway River between Monroe Street and Hazelwood Avenue. The project is maintained by the New Jersey State Department of Environmental Protection. This project does not protect the Robinson's Branch area in the City of Rahway discussed in this report. Existing and future projects by USACE and other entities are summarized in Tables 6 to 8.

Identification of these actions were completed through best practice research and coordination with study stakeholders.

Table 6. Existing and Future USACE Actions Within the Rahway River Watershed

Project Name	Description	Location	Status
East Branch Rahway River Levees	Earthen levees along the east branch Rahway River	South Orange, Essex County	Constructed in 1974
Main Stem Rahway River Levee System	Approximately 3,000 linear ft of levees along the right bank of the main stem Rahway River	City of Rahway, Union County	Constructed in 1966
Medwick Tidal Marsh Mitigation Site	Restoration of 14 acres of low marsh wetland as mitigation for impacts related to the New York/New Jersey Harbor Deepening	Medwick Park, City of Rahway, Union County	Constructed in 2007.
Rahway River Basin Flood Risk Management Feasibility Study	Evaluation of flood storm risk management measures.	City of Rahway Linden and Town ship of Woodbridge, Union County	Feasibility Study in progress, Draft Feasibility Report and EIS issued for public/agency review in December 2016. Completion of Chiefs Report scheduled for 2018.
Hudson-Raritan Estuary Restoration Study	Identification and evaluation of potential ecosystem restoration sites within the Hudson-Raritan Estuary watershed.	Hudson-Raritan Estuary, New York and New Jersey. Numerous sites are within the Arthur Kill, of which the Rahway is a tributary.	Feasibility Study in progress, completion scheduled 2018.
Rahway River Section 1135 Aquatic Ecosystem Restoration Study	Wetland habitat restoration	City of Rahway	Terminated due to lack of funding. Site has since been developed into Lower Essex Street Waterfront Park.
South Branch Rahway River	Emergency Streambank Stabilization of 3,050	Township of Woodbridge	Project has been suspended due to lack of funding.

Section 14 Emergency Streambank stabilization	linear ft of the South Branch Rahway River		

Table 7. Existing/Future Flood Risk Management Projects by Others

Project Name	Description	Location	Responsible Entity	Status
Lenape Park Dam	Dam and 900 linear ft of embankments within Lenape Park	Springfield and Cranford Townships, Union County	Union County	Constructed in 1983
Nomahegan Park Levees	Levees, primarily along the left bank of Rahway River	Cranford Township, Union County	Union County	Unknown completion date
Single Family Home Raising	17 homes raised	Riverside Drive Cranford Township, Union County	Federal Emergency Management Agency (FEMA)	Completed 2013
Home Buyout	Acquisition and removal of home within floodplain	3 homes in City of Rahway	New Jersey, Blue Acres Program	Agreement signed May 2016.

Table 8. Other Actions Within the Rahway River Basin

Project Name	Type	Description	Location	Responsible Entity	Status
East Branch Rahway River Stream and Wetland Restoration	Ecosystem Restoration	Riparian and wetland restoration within USACE channel modification project.	South Orange, Essex County	City of South Orange	Completed 2011
Diamond Mills Pond Repair	Dam rehabilitation	Installation of articulated concrete block, replacement of spillway and 36" sluice gate to control water level.	South Mountain Reservation Millburn Tw Essex County	Essex County	Completed 2012
1,000 Rain Gardens Initiative	Stormwater Management	Installation of rain gardens on public and private properties.	Rahway Watershed	Mayors Council; Association of New Jersey Environmental Commissions	Ongoing
Cranford Municipal Rain Garden	Stormwater Management	Installation of rain garden	Cranford, Union County	Cranford Township	Completed 2014
Kiwanis Park Rain Gardens/Stormwater Management	Stormwater Management	Installation of rain garden/vegetation	City of Rahway, Union County	City of Rahway	Completed 2015
Fish Ladder at Rahway River Dam	Ecosystem Restoration	Installation of fish ladder to improve fish passage at Rahway River Dam	City of Rahway, Union County	Environmental Protection Agency	Feasibility Report completed in March 2006,

					has not been implemented.
Fish Ladder at Milton Lake	Ecosystem Restoration	Installation of fish ladder to improve fish passage in Robinson's Branch	City of Rahway, Union County	Unknown	Unknown
Marshes Creek Resiliency Project	Ecoystem Restoration	Potentially 200 acres of tidal Marsh restoration	City of Linden	Rutgers University, National Fish and Wildlife Foundation	In planning phase.
Rahway Arch	Contamination Remediation	Remediation of site containing heavy metals, voc's and cyanide.	Carteret Borough	Rahway Arch, LLC.	Permits issued by NJDEP; construction initiated.
Tremley Point Connector Road	Transportation	Road connecting Turnpike Interchange 12 to Tremley Point Road.	City of Linden and Borough of Carteret	New Jersey Department of Transportation	Environmental Assessment completed in 2010. Construction has not yet been initiated.
Michael S. Bezega Wetland Observation Park	Ecosystem Restoration	4.45 acre park constructed as stormwater wetalnds along the Rahway River floodplain	City of Rahway in partnership with FEMA, NJDEP and local stakeholders.	City of Rahway	Completed in 2005.

1.7 Study Area

The Rahway River Basin is located in northeastern New Jersey (Figure 2). It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The basin is 83.3 square miles (53,300 acres) in area and is roughly crescent-shaped. Its greatest width is approximately 10 miles in the east-west direction, from the City of Linden to the City of Plainfield. Its greatest length is approximately 18 miles in a north–south direction, from West Orange to Metuchen.

The Rahway River consists of the mainstem Rahway River and four branches. The West Branch flows south from West Orange through South Mountain Reservation and downtown Millburn. The East Branch also originates in West Orange and Montclair and travels through South Orange and Maplewood. These two branches converge near Route 78 in Springfield to form the mainstem of the Rahway River. The Rahway River flows through the municipalities of Springfield, Union, Cranford and Clark before traveling through the City of Rahway. The Rahway River receives the waters of Robinson's Branch at Elizabeth Avenue between West Grand Avenue and West Main Street and the waters of the South Branch at East Hazelwood Avenue and Leesville Avenue before it leaves the City of Rahway and enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill.

The Rahway River Basin is located in northeastern New Jersey. It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The basin is 83.3 square miles (53,300 acres) in area and is roughly crescent-shaped. Its greatest width is approximately 10 miles in the east-west direction, from the City of Linden to the City of Plainfield. Its greatest length is approximately 18 miles in a north–south direction, from West Orange to Metuchen.

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The study area is the lower portion of the Rahway River (Figure 3) affected by coastal storm surge. The study area encompasses portions of the Cities of Linden and Rahway in Union County and the Borough of Carteret and Woodbridge Township in Middlesex County. The portion of the Rahway River affected by coastal storm surge extends roughly five miles from the Arthur Kill into the City of Rahway.

The City of Rahway is located in southern Union County, New Jersey. According to the United States Census Bureau, Rahway has a total area of 4.028 square miles. Of this area, 3.897 square miles is land and 0.131 square miles (3.26%) is water. Rahway is bordered to the northwest by Clark, the northeast by Linden and to the south by Woodbridge Township in Middlesex County.

Woodbridge Township has a total area of 24.507 square miles (63.473 km^2), including 23.213 square miles of land and 1.294 square miles of water (5.28%). The City of Linden has a total area of 11.407 square miles, including 10.675 square miles of land and 0.732 square miles of water (6.42%). The Borough of Carteret has a total area of 5.000 square miles, including 4.418 square miles of land and 0.582 square miles of water (11.65%).

The study area is developed and contains residential, commercial and industrial structures within the floodplain. It is largely suburban and urban with little available open space and lies within the 10th Congressional District, which is currently represented by Donald Payne (D-NJ).

Fluvial Flooding

The majority of the coastal storm surge and fluvial flood areas in the study area are independent regarding the type of flood risk. Coastal storm surge flooding occurs in the City of Rahway and surrounding municipalities but is limited to the lower portion of the basin and does not extend to upstream areas due to changes in elevation and dams on the Rahway River.

A small area along the Robinson's Branch is affected by both types of flooding. As part of the existing conditions analysis a fluvial and coastal storm surge correlation analysis was conducted. The results of that analysis demonstrated a weak correlation between fluvial and coastal storm surge events. It is concluded that a coastal alternative will not completely eliminate the risk of flooding due to a fluvial event. Thus, to account for the probability of a particular location being flooded by a coastal storm surge and fluvial event, a joint probability analysis was performed. New stage-frequency curves were computed for with and without project conditions. By using joint probability curves, the benefits of reducing the risk of flooding from both fluvial and coastal events was accounted for.

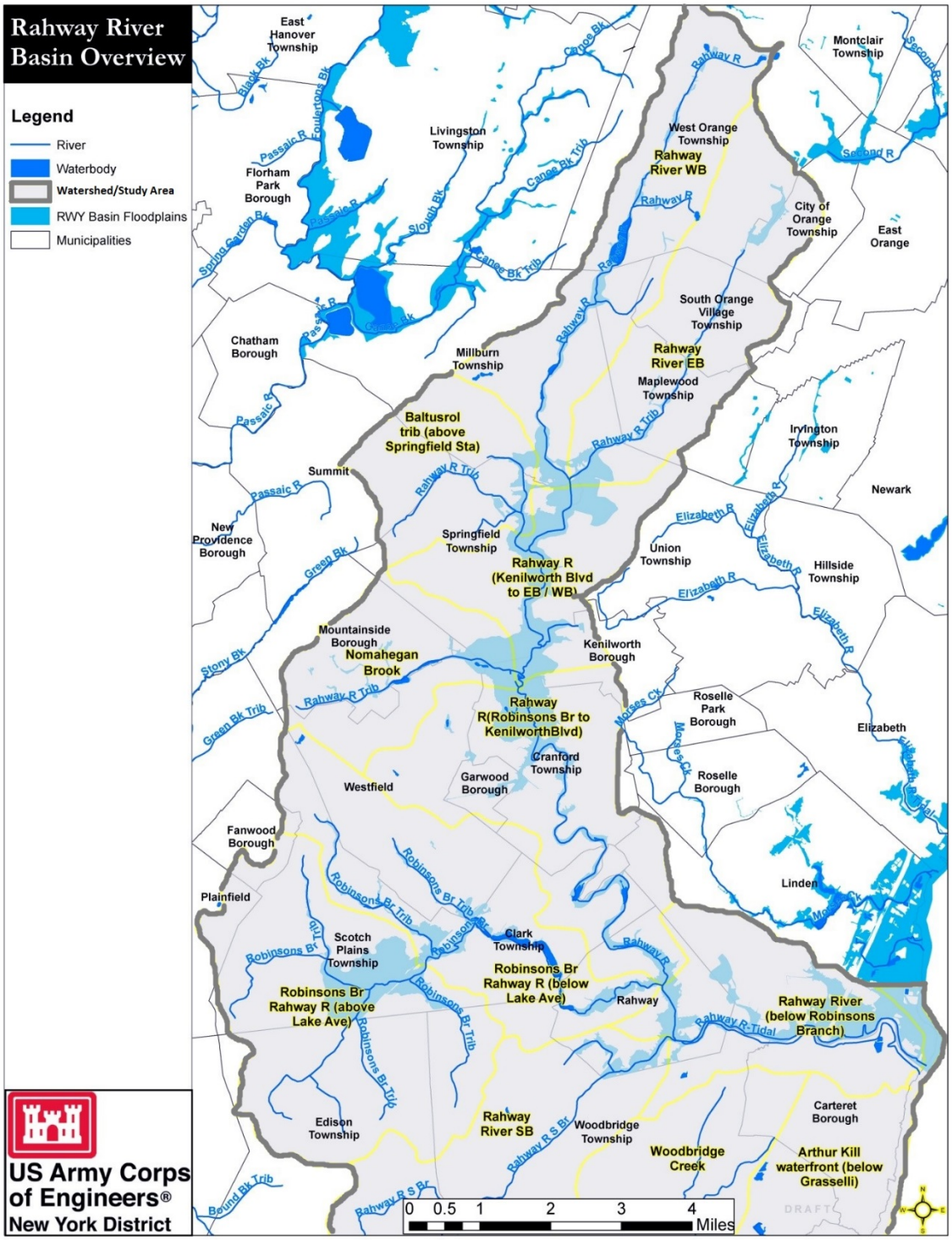


Figure 2. Rahway River Basin

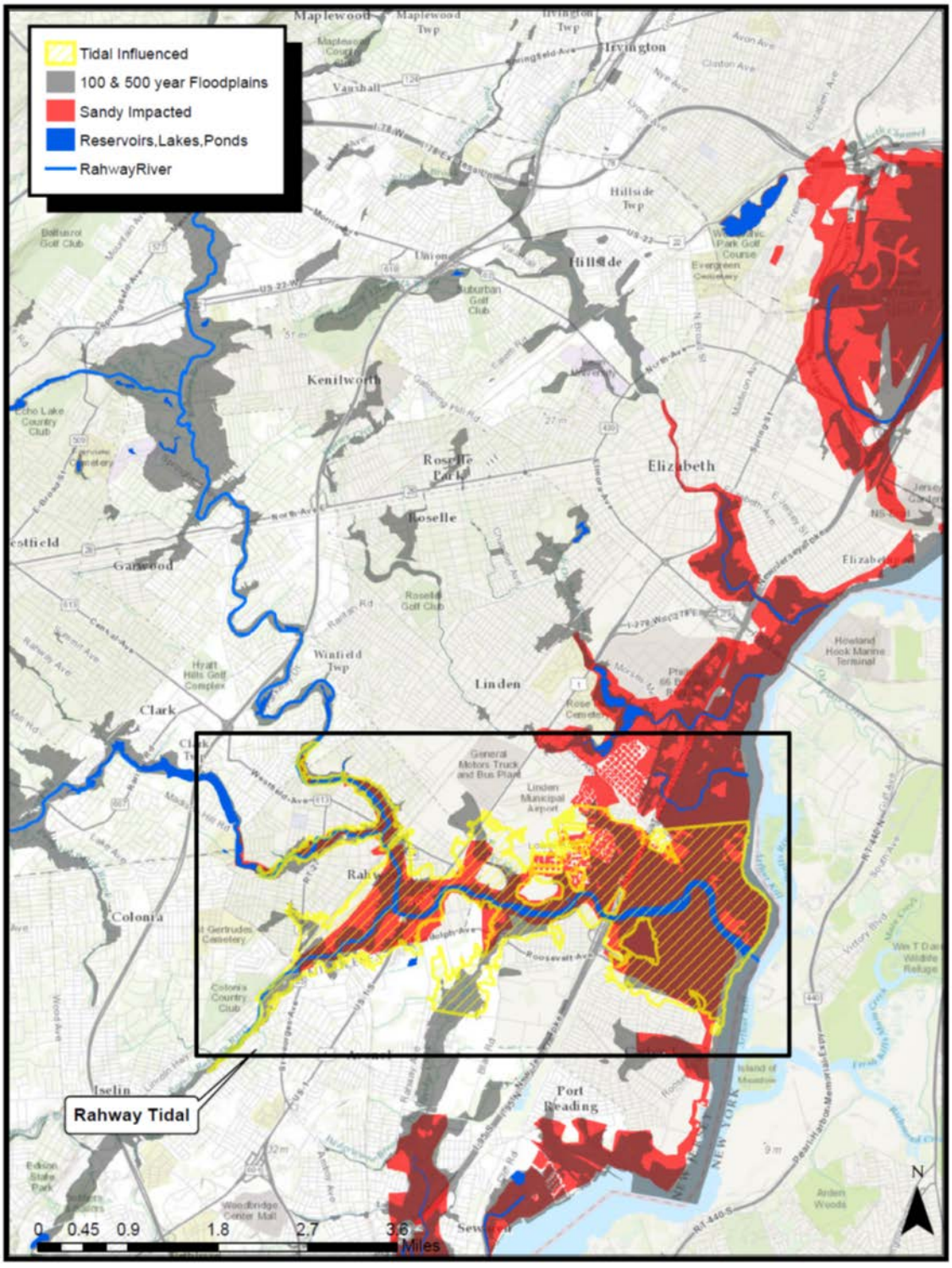


Figure 3. Rahway River Basin Study Area

1.8 Public and Agency Coordination*[3]

Members of the public have had opportunities to comment on the development of study alternatives via public information meetingsIn addition, NJDEP as the non-Federal sponsor, and representatives from municipalities within the project area have been fully involved in study alternative discussions and public meetings throughout the entire plan formulation process.

A public information meeting was held on May 2015 in order to inform regulatory agencies and the public of the feasibility study process and to solicit feedback. Meetings to discuss the preliminary coastal storm risk management alternatives have been held with staff from the New Jersey Department of Environmental Protection Bureau of Flood Control and Dam Safety. A meeting was held in March 2017 with representatives from the New Jersey Green Acres Program to discuss the TSP (Refer to Section 8.0 or Appendix A.8).

The draft integrated FR/EA is being provided to the NJDEP Office of Permit Coordination and Environmental Review to obtain written comments regarding the TSP from the agency. The Office of Permit Coordination and Environmental Review is responsible for coordinating the review of Federal NEPA documents with other NJDEP Divisions such as Green Acres, Fish and Wildlife, Land Use Regulation, Air Quality, Water Resources Management, and the Historic Preservation Office. Additional coordination meetings may be scheduled when more detailed technical information is available for agency review.

Based on coordination with the USFWS, the draft report will be utilized to prepare a draft Fish and Wildlife Coordination Act Report (FWCAR) that summarizes their fish and wildlife conservation and protection recommendations for the TSP. The draft FWCAR is currently scheduled to be submitted to the District in July 2017. Correspondence between the District and the USFWS is located in Appendix A.3.

The Draft FR/EA will be used to complete coordination with NOAA-Fisheries regarding Endangered and Species under their jurisdiction and the Essential Fish Habitat Assessment. A No Effect Determination regarding Endanagered Species is located in Appendix A.1 and the EFH Assessment is located in Appendix A.5.

Consultation has been initiated with the New Jersey State Historic Preservation Office (NJSHPO), Tribes with significant cultural heritage in the region, and local historical organizations.

[3] Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements. Refer to Section 1.2.

Chapter 2.0 **Existing Conditions***

Existing conditions serve as the basis for the characterization of problem identification and projection of future without project conditions. Existing conditions are described in this Chapter (setting, significant storms, and assets at risk) and in Chapter 3 (environmental resources).

2.1 Climate

The climate of the Rahway River basin is characteristic of the Middle Atlantic Seaboard. Marked changes of weather are frequent, particularly during the spring and fall. The winters are moderate in both temperature and snowfall. The summers are moderate, with hot sultry weather in mid-summer and frequent thunderstorms. Rainfall is moderate, and well-distributed throughout the year. The relative humidity is high.

Climate change could cause changes to storm impacts. The most likely scenario for the future without project condition would be the continuation of existing environmental conditions and trends within the study area.

Flood Prone Areas

The downstream reach of the Rahway River, by the Arthur Kill, starts producing minimal damages to the tank farms at the 0.99 annual exceedance probability (AEP), or 1-year, flood at 5.3 ft NAVD'88. Street flooding in this downstream reach begins at the 0.2 AEP (5-year) event and significant damages to structures begin at the 0.04 AEP (25-year) event at the Tower Trailer Park, Mileed Way Industrial Park, and Beverly Street residences in Carteret.

The confluence of the Rahway and South Branch Rivers at Edgar Road Bridge begins street flooding at the 0.5 AEP (2-year) event by Essex Street in Rahway. Significant damages begin at the 0.1 AEP event, including the automotive businesses and residences, without raised foundations, between Route 1 and Milton Avenue.

South Branch starts producing minimal damages to industrial areas at the 0.1 AEP flood at St. Georges Avenue and Elliot Street. Street flooding and residential damage in South Branch begins at the 0.02 AEP (50-year) event at Leesville Avenue.

Levee overtopping at South Branch and Rahway River currently begins slightly above the 0.01 AEP (100-year) event. For future conditions that include some increase in flow and sea level, the levees will be overtopped before the 0.01 AEP event.

Robinson's Branch has street flooding beginning at the 0.02 AEP (50-year) event at the intersection of Central Avenue and St. Georges Avenue and at Hamilton Avenue. Significant damages beginning at the 0.2 AEP (5-year) event occurs at the confluence with the Rahway River near the Rahway Arts District.

Flooding upstream is not heavily influenced by coastal storm surge. Although coastal storm events alone would not cause significant damages upstream of the confluence, the joint-

probability of a fluvial and coastal storm surge event occurring at Robinson's Branch and south of the Rahway Water Supply Dam suggests that a 0.04 AEP (25-year) event would cause damages.

Figures 1 and 3 show the areas in the Rahway River Basin subject to flooding from coastal storm surges.

Existing Hydraulic Features

Some areas along the Rahway River have seen a decrease in flood risk due to improvements implemented through the years. The USACE South Branch Flood Risk Management Project of 1968 is the only project that falls within the coastal storm surge boundaries of this study. The flood risk management project is a combination of levees, floodwalls, and channel modification. The right bank of the Rahway River between Monroe Street and East Hazelwood Avenue has levees. The left bank of the South Branch River from Regina Avenue to Sterling Place is levee and from Sterling Place to Hazelwood Avenue is floodwall. This project also consists of a stop-log road closure structure at the Hazelwood Avenue Bridge. This system was constructed in the 1970's and is periodically inspected by the USACE Dam and Levee Safety Program.

The levee system was regraded in 2015 to the original design height of 12.6 ft NAVD'88 after the system was overtopped twice, slightly during Tropical Storm Irene in 2010 and by a few inches during Hurricane Sandy in 2011. Inspections had reported a settlement of about 1 ft. across the entire levee system.

2.2 Storm Types

The storms which occur over the northeastern states have their origins in or near the North Atlantic Ocean and may be classified as: extratropical storms; which include thunderstorms, and cyclonic (transcontinental) storms; and tropical storms which include the West Indies hurricanes. There are also nor'easter storms or extratropical storm, which developed due to rapid convective circulation when a tropical marine air mass is lifted suddenly on contact with hills and mountainous terrain, causes heavy rains usually in the summer and fall season. Thunderstorms, resulting from rapid convective circulation, usually in July, are limited in extent and cause local flooding on flash flood prone streams. A cyclonic storm, due to its transcontinental air mass movement with attendant "highs" and "lows," usually occurs in the winter or early spring, and is a potential flood-producer over large areas because of its widespread extent. The West Indies hurricanes of tropical origin proceed northward along the coastal areas, accompanied by extremely violent winds and torrential rains of several days' duration.

A review of storms which have occurred in the northeastern states reveals that the Rahway River basin is located in the center of the North Atlantic storm belt. The primary problem encountered in the study area is flooding with elevated water levels associated with coastal storm surge on the Rahway River and tributaries within the study area.

Winds

Wind data is not available within the project limits, but is available for Sandy Hook, located approximately thirteen miles southeast from the mouth of the Rahway River. A wind rose was constructed based on data covering a 10-year period between 1924 and 1934 and indicates that 37% of the wind occurrences are from the northwest. Winds from the north and west occur more than 15% of the time. Winds from the northeast, south and southwest occur approximately 10% of the time. The data also shows that there were 10 occasions when winds exceeded 50 mph between 1924 and 1934. The winds at Sandy Hook were greater than 30 mph about 20% of the time. The northwest and northeast account for the most winds greater than 50 mph. The maximum storm wind velocity recorded near the study area was 78 mph at Long Branch, New Jersey, located south of Sandy Hook occurring on June 11, 1953. The maximum recorded winds for Hurricane Sandy near the study area was at Perth Amboy (XPER) (40.50N, 74.28W) on 30 October 2012 at 0210 at a height of 10 meters. The maximum sustained velocity (2 minute) was 46 knots (53 mph). The maximum gust was 63 knots (72 mph).

Tides

The project area experiences semidiurnal tide cycles, i.e. there are two high tides and two low tides every lunar day. The mean range of tide is 4.98 feet, the mean spring range is 5.51 feet, and the mean tide level is -0.25 feet NAVD'88 based on NOAA benchmark data for station gage 8519483, Bergen Point West Reach NY, 1983 to 2001 epoch.

Tidal Datum

Tidal datum referred to North American Vertical Datum in 1988 for the study site is shown in Table 9. The NAVD datum is approximately 2.95 ft above MLLW.

Table 9. Bergen Point Gage ID: 8519483

Tidal Datum	Elevation in ft above NAVD88
Mean Higher High Water	2.56
Mean High Water	2.24
Mean Sea Level	-0.18
Mean Tide Level	-0.25
Mean Low Water	-2.74
Mean Lower Low Water	-2.95

Stage-Frequency Relationship

The 2015 North Atlantic Coast Comprehensive Study (NACCS) is a USACE study that identifies flood risk in coastal communities as a support tool for risk management and resiliency. NACCS technical products have been made available for coastal storm risk management projects, specifically the Coastal Hazards System webtool. This tool provides rating curve data for "SavePoints" along the coast and project area. The NACCS coastal stage-frequency curve at Arthur Kill/Rahway Mouth (node ID: 11659) was used to develop

all annual chance exceedance (ACE) peak stages for the tidal boundary condition hydrographs. The rating curve for present conditions is shown in Table 10. Since the Rahway River flows into the Arthur Kill (an estuary), it was necessary to perform a Tidal-Fluvial correlation to establish the upstream flows that are expected to occur during a storm surge, or coastal storm event. The peak of each tidal stage frequency hydrograph is coincidental to peak flow at the mouth of the Rahway River for the 99.9%, 50%, and 20% ACE fluvial events. The duration of each storm is variable based on the Port Monmouth frequency-duration of hypothetical storms.

Table 10. NACCS Rating Curve for Arthur Kill/Rahway Mouth

Annual Chance Exceedance	Frequency Event (years)	Stage (ft-NAVD88)
99.9%	1	5.10
50%	2	6.05
20%	5	7.33
10%	10	8.35
4%	25	9.40
2%	50	10.94
1%	100	12.28
0.5%	200	13.73
0.2%	500	15.56

Sea Level Change

Department of the Army, Engineering Regulation ER 1100-2-8162 provides guidance on incorporating the effect of projected sea level change (SLC) across the project life of USACE projects. The USACE low rate of future SLC is based in the historic rate in the vicinity of the project area. Readings of the NOAA tide gage at Bergen Point over a 33-year period show sea levels increasing at an average annual rate of 0.016 ft per year. This equates to 0.8 ft in the 50-year period of analysis of the study.

Topographic Data

LIDAR data from 2007 of the study area is available as well as 2012 topographical mapping in the City of Rahway.

Shoreline Conditions

The shoreline of the Rahway River area along the Arthur Kill consists of docks, bulkheads, industrial areas and tank farms. The elevation of the ground surface in the shoreline region ranges from 0 to 25 feet NAVD88.

Storms

Two types of storms are of primary significance at the project site: (1) tropical storms which typically impact the project site area from July to October, and (2) extratropical

storms which are primarily winter storms occurring from October to March. Extratropical storms (northeasters) are usually less intense than hurricanes, but tend to have a much longer duration. These storms often cause high water levels and intense wave conditions, and are responsible for significant damages and flooding throughout the New Jersey coastal region.

Storm History

Hurricane Sandy: 22 – 29 October 2012

Hurricane Sandy initially formed as a tropical depression in the southwestern Caribbean. Sandy weakened somewhat and then made landfall as a post-tropical cyclone near Brigantine, New Jersey with 70-kt maximum sustained winds. Because of its extensive size Sandy drove a very severe storm surge into the New Jersey and New York coastlines.

The highest storm surge measured by a National Ocean Service (NOS) tide gauge in New Jersey was 8.57 feet above normal tide levels at the northern end of Sandy Hook in the Gateway National Recreation Area. Since the station failed and stopped reporting during the storm, it is likely that the actual storm surge was higher. Farther south, the NOS tide gauges in Atlantic City and Cape May measured storm surges of 5.82 ft and 5.16 ft, respectively.

The following inundations, expressed above ground level, were prevalent along the coast due to the storm tide:

Monmouth and Middlesex Counties	4 – 9 feet
Union and Hudson Counties	3 – 7 feet
Essex and Bergen Counties	2 – 4 feet
Ocean County	3 – 5 feet
Atlantic, Burlington, and Cape May Counties	2 – 4 feet

The highest storm surge occurred in areas that border Lower New York Bay, Raritan Bay, and the Raritan River. The highest high-water mark measured by the USGS was 8.9 ft above ground level at the U.S. Coast Guard Station on Sandy Hook. This high-water mark agrees well with data from the nearby NOS tide gauge, which reported 8.01 ft above mean higher high water (MHHW) before it failed. Elsewhere, a high-water mark of 7.9 ft above ground level was measured in Keyport on the southern side of Raritan Bay and a mark of 7.7 ft was measured in Sayreville near the Raritan River.

As storm surge from Sandy was pushed into New York and Raritan Bays, seawater surge occurred within the Hudson River and the coastal waterways and wetlands of northeastern New Jersey, including Newark Bay, the Passaic and Hackensack Rivers, Kill Van Kull, and Arthur Kill. Significant inundations occurred along the Hudson River in Weehawken, Hoboken, and Jersey City, where many high-water marks indicated that inundations were between 4 and 6.5 ft above ground level. Inundations of 4 to 6 ft were also measured across Newark Bay in Elizabeth and the area around Newark Liberty International Airport.

Conversation between the Corps and the Middlesex Office of Emergency Management (OEM) revealed that municipalities within the lower portion of the Rahway River Basin and general area suffered coastal storm surge induced flood damages from Sandy. It is estimated that Hurricane Sandy caused tens of millions of dollars of damage in the study area. The City of Rahway sustained an estimated $35 million in damages with approximately $15 million of it to city property and another $20 million to private property. Damages included costly repairs to the existing Corps levee pump stations. Damages for the Borough of Carteret are estimated at $53.1M. Woodbridge Township suffered damages estimate at $7M with 200 structures damaged, including 40 destroyed. The PSE&G power plant in Woodbridge was destroyed. Blue Acres at the NJDEP is in the process of buying out 175 structures in the township.

During Hurricane Sandy, bulk fuel tanks were damaged and fuel flowed into the Arthur Kill. The storm temporarily shut down oil refineries in the study area leading to shortages of fuel in northern New Jersey. No deaths linked with Hurricane Sandy have been identified within the study area.

Tropical Cyclone Irene: Storm of 27-28 August 2011

Irene made its United States landfall near Little Egg Inlet, New Jersey on Sunday, August 28, 2011 as a hurricane with maximum sustained winds of 75 mph. At this point Irene had weakened to a tropical storm. Tropical Storm Irene produced about three to 13 inches of rain on the watersheds within the New York District's civil works boundaries in northern New Jersey and southern New York in about a 16 hour period between Saturday, August 27 and Sunday, August 28. Tropical Storm Irene rainfall total for the Rahway River basin was about 10 inches. Irene generated a storm surge of 4 to 6 feet along the New Jersey coast and a surge of 3 to 6 feet in the New York City and Long Island areas.

Other Storm Events

Various other storms, tropical storms, northeasters and hurricanes caused coastal storm surge inundation and damage in recent decades. These include:

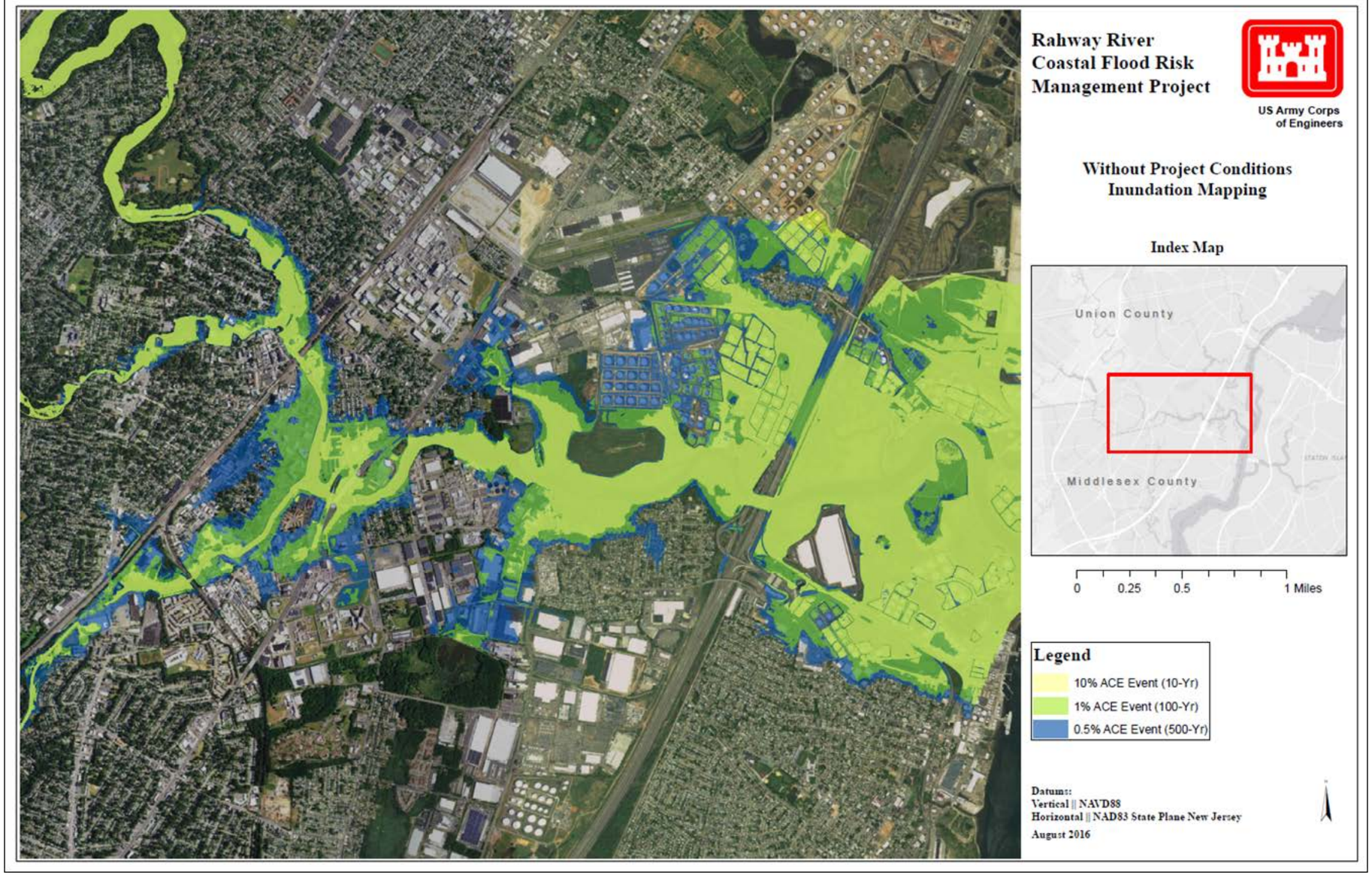
- Storm of 15-16 April 2007
- Tropical Storm Floyd on 15-16 September 1999
- Storm of October 19 1996
- Northeaster Storm of 11-12 December, 1992
- Halloween Northeaster of 31 October 1991
- Hurricane Gloria on 27 September 1985
- Coastal Storm of 29-30 March 1984.
- Tropical Storm Doria 26-28 August 1971
- Coastal Storm of 6-8 March 1962
- Hurricane of 12 September 1960 (Donna)
- Storm of 6-7 November 1953
- Storm of 25 November 1950
- Hurricane of 14 September 1944

Flow Line Computation

The calibrated Hydrologic Engineering Center – River Analysis System (HEC-RAS) models of the Rahway River were used to determine the present and future, without project conditions water surface elevations (WSEs) for the 0.2, 0.4, 1, 2, 4, 10, 20, 50 and 100% chance of annual exceedance events (1, 2, 5, 10, 25, 50, 100, 250, and 500-yr frequency). Table 11 shows the expected increase in WSEs due to urbanization in the next 50 years for several annual chance of exceedance events. These results demonstrate a minimal increase in flooding due to urbanization of the basin.

Table 11. Difference in WSEs Between Present and Future Without Project Conditions Location	**HEC-STA**	**W/O Project Future Increase in WSEs (ft.)**			
		0.2 AEP (5-yr)	0.04 AEP (25-yr)	0.01 AEP (100-yr)	0.002 AEP (500-yr)
Rahway River at Rahway Water Supply Dam	34903.35	0.18	0.09	0.09	0.13
Robinson's Branch at Milton Lake Dam	8751.545	0.03	0.04	0.04	0.04
Robinson's Branch at Rahway Confluence	175.4458	0.47	0.42	0.46	0.14
South Branch Upstream	11216.78	0.04	0.04	0.01	0.02
South Branch and Rahway River Confluence	210.7962	0.62	0.62	0.94	0.77
Rahway at Arthur Kill	5.520991	0.81	0.81	0.81	0.81

Figure 4 illustrates the 0.2, 1 and 10% chance of annual exceedance floodplains for the study area.



***Note: This is the coastal storm surge inundation only. Representation does not include joint-probability WSEs.**

Figure 4. "Without Project" Present Condition Inundation Map for the 10%, 1%, and 0.5% Annual Chance Exceedance Events.

Chapter 3.0 Existing Conditions Affected Environment*

This description of the existing environment conditions is in accordance with the requirements of National Environmental Policy Act (NEPA), and serves as the baseline for Chapter 6: Environmental Effects and Chapter 7: Cumulative Effects of this draft integrated report.

3.1 Land Use

Municipalities within the project area have little undeveloped land, ranging from essentially none to a few percent of the total area within each municipality. Most of the watershed is heavily urbanized, of which residential housing developments comprise the largest sub-category with remaining uses consisting of recreation, municipal, commercial and industrial. Undeveloped lands consist predominantly of County and municipally owned open space.

3.2 Topography, Geology and Soils

3.2.1 Geology and Topography

The project area is located within the Piedmont Physiographic Provence. The Piedmont Provence is described as gently rolling plains, 200 to 400 ft above sea level, and includes the crescent-shaped Watchung Mountains ranging between 450 to 900 ft above sea level. The underlying geology is mainly shale with siltstones and sandstones occurring infrequently, with the mountains being composed of basalt flows. Glacial deposits overlie the surface throughout the Piedmont area (Amy S. Greene Environmental Consultants Inc., 2014).

The project area generally has flat to gently sloping topography consistent with its location at the confluence of numerous branches of tidal and nearly tidal streams and rivers. Elevations within the project area ranges from sea level to 25 above mean sea level.

3.2.2 Soils

Dominant soil types within the project area consist of Boonton loam, Boonton-Urban land complex, Haledon silt loam, Haledon-Urban Land complex, Transquaking mucky peat, fluvaquents, and Udorthents.

Within the project area, Boonton soils occur on 3 to 8 percent slopes. This soils series consists of deep or very deep moderately well and well drained soils formed in till on uplands. The soils formed in glacial till composed mostly of red to brown shale, sandstone, basalt, and some granitic gneiss (NRCS, 2012).

The Urban land component of the Boonton-Urban Land complex is classified as land mostly covered by streets, parking lots, buildings and other structures of urban areas with slopes ranging from 0 to 8 percent (NRCS, 2002).

The Haledon component is on ground moraines on till plains with parent material consisting of coarse-loamy basal till derived from basalt. The natural drainage class is somewhat poorly drained. This soil series consists of very deep, somewhat poorly drained

soils in low positions on undulating uplands. Slope ranges from 0 to 15 percent (NRCS, 2013a).

Fluvaquent soils generally occur on slopes ranging from 0 to 3 percent. Parent material consists of recent alluvium and are commonly found on floodplains and in river valleys. The natural drainage class is somewhat poorly drained and is frequently flooded.

The Hasbrouck soil series consists of very deep, poorly drained soils in depressions on uplands with slopes ranging from 0 to 8 percent. They generally occur on nearly level or gently sloping depressions, drainage ways, and areas adjacent to narrow floodplains of minor streams on uplands. They typically formed from eroded and redeposited glacial materials overlying till (NRCS, 2013b).

The Transquaking mucky peat soils are found along coastal plains in brackish estuarine marshes along tidally influenced rivers and creeks. Slopes in which this soils occurs range from 0 to 2 percent. The parent material consists of organic deposits underlain by loamy mineral sediments. This soil type is very poorly drained and frequently flooded by tidal waters (NRCS 2002).

The Udorthents soil type is typically identified in areas where the original in-situ soils have been altered through human activity. Substratums included within this series includes refuse substratum, where areas have been used for refuse disposal (e.g. landfill), and loamy substratum, where the in-situ soil has either been removed and/or covered with a loamy fill material These soils typically consist of moderately deep to deep well drained to somewhat poorly drained soils. Within the project area, Udorthents are found on slopes ranging from 0 to 8 percent (NRCS, 2016).

Hydric Soils

Transquaking, Fluvaquents and Hasbrouck soils are included on the list of hydric soils for New Jersey developed by the Natural Resources Conservation Service. Soils with this classification are those saturated through natural or artificial means sufficiently enough to support the growth and regeneration of hydrophytic vegetation (NRCS 2007).

Prime Farmland Soils

Prime Farmland Soils are defined by the USDA as land that has the best combination of characteristics for producing food. It can have any land use ranging from cultivated land, pastureland, forest, or other; however, it is usually not urban or water areas. The USDA states that, “The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management and acceptable farming methods are applied.”
Boonton and Haledon soils are defined as prime farmland soil (NRCS, 2016).

3.3 Water Resources

3.3.1 Surface Water

Originating in the Watchung Mountains in Essex County, the Rahway River flows south for approximately 24 miles before discharging into the Arthur Kill strait. The Rahway

River Watershed has drainage area of 83 square miles. Within the project area, the Rahway River has two major tributaries; Robinsons Branch and the South Branch Rahway River. Several tidally influenced tributaries to the Rahway River are located in the lower portion of the project area. Four of the more notable tributaries include Kings Creek located in wetland complex on the left bank of the Rahway River just north of Hawk Rise Sanctuary, Caseys Creek located in wetland complex along the right bank of the Rahway River within the Joseph Medwick Memorial Park, Marshes Creek, located along the left bank of the Rahway River south of the New Jersey Turnpike and Cross Creek, located on the right bank of the Rahway River south of the New Jersey Turnpike (Figure 6).

The channel width of the Rahway River within the project area ranges from approximately 50 feet in the northern portion of the project area to approximately 475 feet near the confluence with the Arthur Kill. The depth of the river ranges from two feet in the northern portion of the project area to an average depth of 10 ft near the confluence with the Arthur Kill (Miller, 2012), (NOAA, 2012). The substrate of the Rahway River in the northern portion of the project area is comprised of cobble, gravel and sand (Miller, 2012). Around the Route 1 bridge the substrate transitions to a predominantly silty-muck substrate (USACE, 2001). This substrate type is consistent for remaining segment of the Rahway River to its confluence with the Arthur Kill where the substrate predominantly consists of mud and sand (NJDOT 2010).

Most of the watershed is heavily urbanized, of which residential housing developments comprise the largest sub-category with remaining uses consisting of recreation, municipal, and commercial, and industrial. Undeveloped lands consist predominantly of County and municipally owned open space and wetlands.

Along with receiving point and non-point discharges related to stormwater runoff, the Rahway River has experienced modifications associated with water supply, recreation, flood risk management, and development of infrastructure. Within the vicinity of the northern portion of the project area in the City of Rahway, the Rahway River Dam is used by United Water to withdraw approximately 4.85 million gallons of water per day from the river to serve approximately 26,500 customers (United Water, 2016). A levee system approximately 3,000 linear feet long is located along the right bank of the Rahway River within the vicinity of the Rahway Municipal Complex.

3.3.2 Water Quality and Habitat

Within the project area, the Rahway River has three separate water quality classifications (Figure 5). From its headwaters until around the railroad tracks in the City of Rahway, the Rahway River is designated as FW2-NT. Robinson's Branch is also designated as FW2-NT. FW2-NT waters are those freshwaters not supporting trout spawning or maintenance. By definition, designated uses for FW2 waters include: 1. Maintenance, migration and propagation of the natural and established biota; 2. Primary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment and disinfection; and 5. Any other reasonable uses. Non-trout waters are those "not generally suitable for trout because of their physical, chemical or biological characteristics but are suitable for a wide variety of other fishes".

Between the railroad tracks and the Route 9 bridge, the classification of the Rahway River changes to SE2. Designated uses of SE2 are: 1. Maintenance, migration and propagation of the natural and established biota; 2. Migration of diadromous fish; 3. Maintenance of wildlife; 4. Secondary contact recreation; and 5. Any other reasonable uses. The South Branch Rahway River is designated SE2 near its confluence with the Rahway River but then changes to FW2-NT in its upper reaches.

From the Route 9 bridge to the confluence with the Arthur Kill, the water classification of the Rahway River is saline waters of estuaries 3 (SE3). The four tidal tributaries, Kings Creek, Casey's Creek, Marshes Creek and Cross Creek are also classified as SE3. Designated uses for SE3 waters include: 1. Secondary contact recreation; 2. maintenance and migration of fish populations; 3. migration of diadromous fish; 4. maintenance of wildlife; and 5. any other reasonable uses (N.J.A.C. 7:9B, 2011).

The NJDEP Bureau of Freshwater and Biological Monitoring (BFBM) conducts monitoring of surface water quality through a combination of chemical analyses and surveys of macroinvertebrates and/or fish surveys. A NJDEP BFBM fish and macroinvertebrate monitoring station (FIBI019 and ANO195 respectively) is located immediately above the northern boundary of the project area.

Salinity levels range from around 8 parts per thousand (ppt) within the upper portion of the project area near the Route 1 bridge to 17 to 26 parts per thousand in the lower portion of the project area near the confluence of the Arthur Kill (USACE, March 2004)(NJDOT, 2010).

An evaluation of the habitat within the monitoring station by the NJDEP BFBM during fish and benthic surveys noted characteristics consistent with a stressed aquatic community. These characteristics included sediment deposition, channel modification, severe bank erosion, poor flow regime, and the absence of a vegetated riparian zone along the left bank. In addition, several storm water outfalls which directly drain stormwater runoff from adjacent roadways were noted (Vile, September 2011).

The segment of the Rahway River below Robinson's Branch is included on the 303(d) List of Impaired Waters in the New Jersey draft 2014 Integrated Water Quality Monitoring and Assessment Report (NJDEP, 2015). Parameters causing the use impairment are listed in Table 12. In addition, the NJDEP has issued fish consumption advisories for blue crab, striped bass, American eel, white perch and white catfish within the Arthur Kill and its tidal tributaries, which includes the Rahway River (NJDEP, 2016).

Table 12. Sources of Parameters Causing Use Impairment Within the Lower Rahway River

Parameter	Source 1	Source 2	Source 3	Source 4
Heptachlor epoxide	Contaminated sediments	Source Unknown		
Chlordane in Fish Tissue	Contaminated sediments	Source unknown		
DDT in Fish Tissue	Contaminated sediments	Source Unknown		
Hexachlorobenzene	Source Unknown			
Benzo(a)Pyrene	Source Unknown			
Mercury in Fish Tissue	Atmospheric Deposition - Toxics			
PCB in Fish Tissue	Contaminated Sediments	Source Unknown		
Dioxin	Atmospheric Deposition – Toxics	Combined Sewer Overlfows	Municipal Point Source Discharges	Urban Runoff/Storm Sewers
Dieldrin	Contaminated Sediments	Source Unknown		

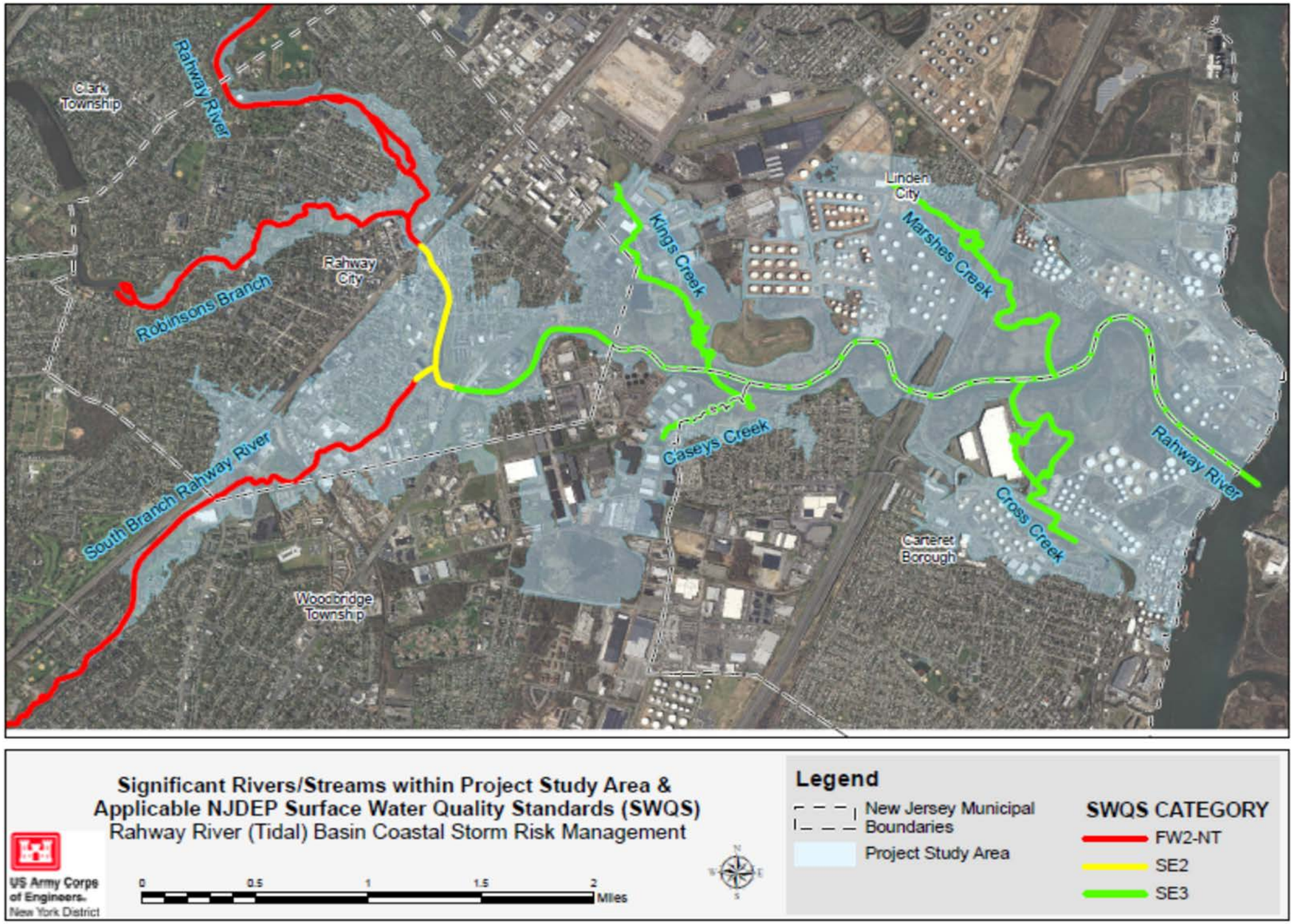


Figure 5. Surface Water Quality Designations

3.3.3 Wetlands

Federal (33 CFR 328.3(b); EO 11990) and State (N.J.A.C. 7:7A1.4) definitions of wetlands are similar, identifying wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." As defined above, wetlands generally include swamps, marshes, bogs, and similar areas.

A review of New Jersey's GIS environmental mapping database (NJ Geoweb) and the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps was conducted to assess potential wetlands within the study area (Figure 6). Both NJ Geoweb and the USFWS NWI maps indicate the presence of multiple wetland complexes within the Rahway River corridor within the project area. In the upper portion of the study area, there is a three acre forested wetland near the confluence of the South Branch Rahway and Rahway main stem. Further downstream in the lower portion of the project area, there are several large wetland complexes ranging from 12 acres to over 20 acres in the southern portion of the study area. The wetland complexes are predominantly tidal marsh, although a freshwater emergent wetland is located within the interior of one of the complexes located along the left bank of the Rahway River. Refer to Figure 1 in Appendix A.1 for the various wetland types within the project area.

Most of the wetlands in the project area have been subjected to significant human alterations, such as encroachment from residential, commercial, and industrial development. This activities have contributed to changes in the hydrology that have resulted in wetland degradation.

The District completed a 14 acre tidal marsh wetland mitigation within the Joseph Medwick Memorial Park in 2007 to compensate for wetland impacts associated with the Arthur Kill Channel deepening related to the overall New York/New Jersey Harbor deepening project.

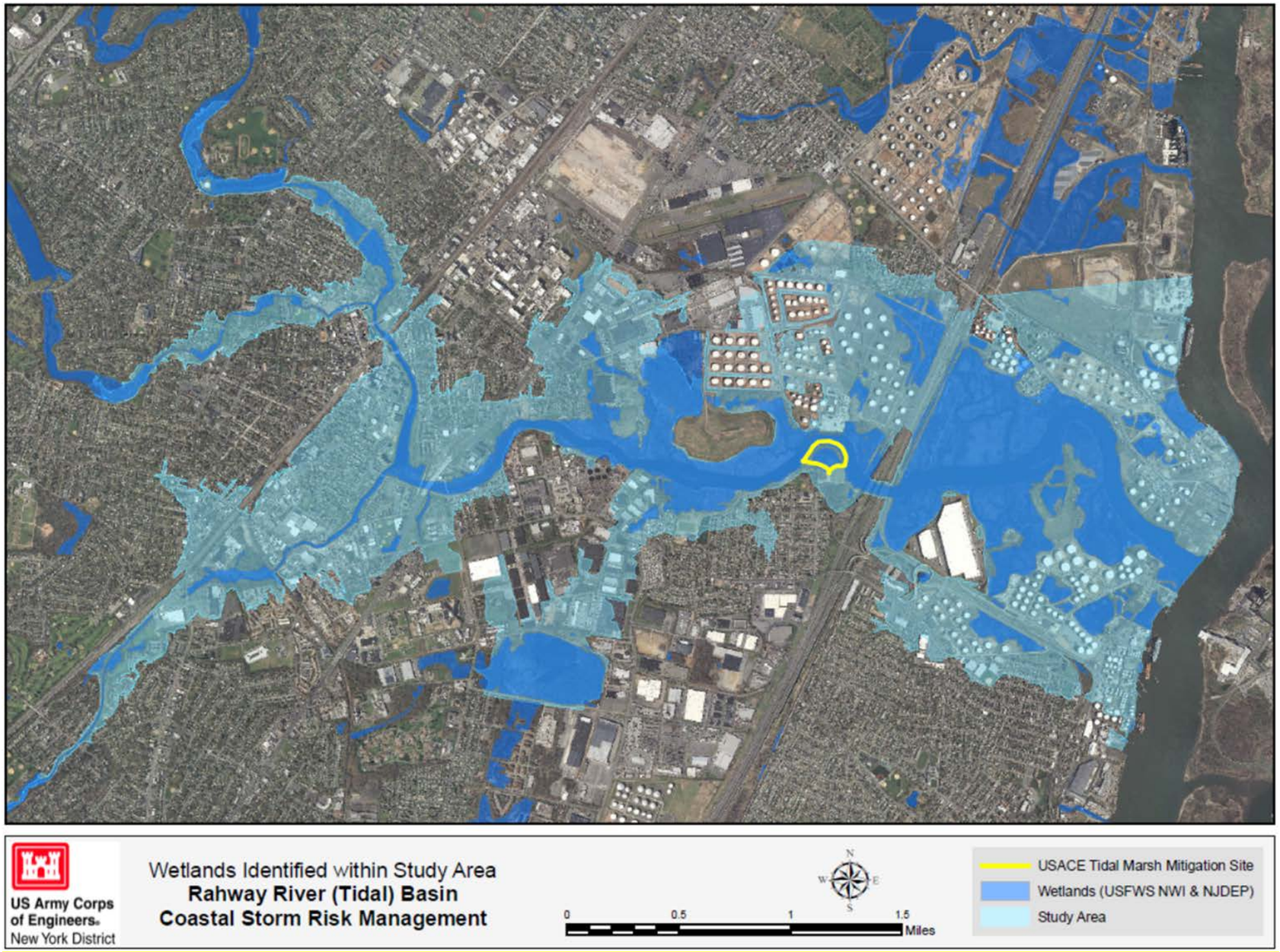


Figure 6. Wetlands Within the Project Area

3.4 Vegetation

3.4.1 Uplands and Riparian Corridor

The majority of the upland area within the project area consists of residential, commercial and industrial development with few areas of undisturbed mature deciduous vegetation. Vegetation within uplands consists mostly maintained lawns dominated by a variety of common native and nonnative grass species interspersed with deciduous shrubs and trees.

The New Jersey Flood Hazard Area Control Act Rules, N.J.A.C. 13 (FHACAR) establishes and requires the preservation of riparian zones. The width of the established riparian zone is based on the environmental resources being protected and can range from 50, 150 or 300 feet as measured from the side of surface waters. Given that the Rahway River and Robinson's Branch are designated FW2-NT and SE3 the riparian zone is 50 feet as described in N.J.A.C. 7:13-4.1c 3.

Within the northern portion project area, development occurs right up to the streambank, thus limiting the riparian zone to a width ranging from 5 to 25 feet. Development within the southern portion of the project area situated further away from the river. Therefore, the majority of the 50 feet within the regulated riparian zone is vegetated.

Common tree and shrub species observed within the upland areas and riparian zone within portions of the northern portion of the project area include sweet gum (*Liquidambar styraciflua*), eastern cottonwood, black locust (*Robinia pseudo-acacia*), black cherry (*Prunus serotina*), indigobush (*Amorpha fruticosa*), black locust (*Robinia pseudoacacia*), white mulberry (*Morus alba*), American elm (*Ulmus americana*), winged sumac (Rhus copallina), and willow oak (Quercus phellos).

Invasive plant species observed within the project area include Norway maple (*Acer platanoides*), tree of heaven (*Ailanthus altissma*), Japanese knotweed (*Fallopia japonica*), mugwort (*Artesemia vulgaris*), multiflora rose (*Rosa multiflora*), and common reed (*Phragmites austrailias*).

3.4.2 Wetlands

Species occurring within the forested wetland in the northern portion of the project area include pin oak (*Quercus palustris*), box elder (*Acer negundo*), red maple (*Acer rubrum*), southern arrowwood (*Viburnum dentatum*), American elder (*Sambucus canadensis*), spotted touch-me-not (*Impatiens capensis*), and miscellaneous sedges and grasses.

Species common to the low marsh wetlands within the project area include; smooth cordgrass (*Spartina alterniflora*), saltmeadow cordgrass (*Spartina patens*), maritime marsh-elder (*Iva frutescens*), fleabane (*Pluchea purpurascens*), salt marsh spike rush (*Eleocharis halophila*), water hemp (*Acnida cannabina*), and orach (*Atriplex patula*).

Common reed (*Phragmites australis*) is the dominant species species found within high marsh within the project area. Other species found along the Phragmites/upland transition zone include tree of heaven, and multi-flora rose (*Rosa multiflora*).

The wetland mitigation site constructed by the District in 2007 within Joseph Medwick Memorial Park included planting of vegetation within four distinct zones: low marsh, supratidal zone, upland

transition and upland. Vegetation planted within the low marsh zone included smooth cordgrass, saltmeadow cordgrass (*Spartina patens*). Within the supratidal zone maritime marsh-elder, saltmeadow cordgrass were planted. The upland transition zone included saltgrass (*Distichlis spicata*), saltmarsh rush (*Juncus gerardii*), groundsel tree (*Baccharis halmifolia*). Upland vegetation included beach plum (*Prunus maritima*), northern bayberry (*Myrica Pensylvanica*), and winged sumac (*Rhus copallinum*) (USACE, December 2004).

3.5 Aquatic Resources and Wildlife

3.5.1 Fish

The NJDEP Division of Fish and Wildlife conducts fish sampling studies in New Jersey waters as part of their long-term biomonitoring program to determine the level of water quality impairments to state waters. A fish survey station (FIBI 019) was established within the Rahway River along Church Street in Rahway approximately 0.75 miles from the northern border of the project area (Figure 2, Appendix A.1). Based on fish surveys conducted in 2010, fish species that inhabit the Rahway River include American eel (Anguilla rostrata), tessellated darter (*Etheostoma olmstedi*), redbreast sunfish (*Lepomis auritus*), banded killifish (*Fundulus diaphanous*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*), spottail shiner (*Notropis hudsonius*), hybrid green sunfish and pumpkinseed (*Lepomis cxg*), largemouth bass (*Micropterus salmoides*), and white sucker (*Catostomus commersoni*) (NJDEP BFBM, 2011). The majority of species collected generally consist of warm water species that are relatively tolerant to degraded water quality conditions and are generalist feeders.

The District conducted a one year one time sampling in the creek in the Joseph Medwick Memorial Park in fall of 2004 as part of a wetland mitigation project. The only species caught were killifish (USACE, December 2004).

In addition, the USACE conducted a spring and fall fish survey of the Rahway River directly adjacent to the Project Area in 2002 (USACE 2002e)(figure 2, Appendix A.1). The dominant species captured were mummichog (*Fundulus heteroclitus*), followed by white perch (*Morone americana*), common carp (*Cyprinus carpio*), pumpkinseed, northern hog sucker (*Hypentelium nigricans*), striped bass (*Morone saxatilis*), alewife (*Alosa pseudoharengus*), American eel, gizzard shad (*Dorosoma cepedianum*), and bluefish (*Pomatomus saltatrix*) (USACE, March 2004).

3.5.2 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as “those waters and s substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The MSFCMA requires federal agencies to conduct an assessment to determine whether the proposed action “may adversely affect” designated EFH and to consult with NMFS on activities that may adversely affect Essential Fish Habitat. As part of the consultation, the Federal Agency must perform an EFH assessment and coordinate the assessment with the National Oceanic and Atmospheric Adminstration – National Marine Fishery Service (NOAA-NMFS). The objective of an EFH assessment is to determine or relevant commercial, federally managed fisheries species within the proposed action area.

Based on a review of the NOAA-NMFS EFH Mapping System, the portion of the Rahway River from just south of Route 9 bridge is designated as EFH for all life stages (eggs, larvae, juvenile and adult) for smooth dogfish (*Mustelus canis*). In addition, the Rahway River from immediately below the New Jersey Turnpike to the confluence of the Arthur Kill is designated as EFH for smooth dogfish, summer flounder (*Paralichthys dentatus*) and inshore longfin squid (*Doryteuthis pealeii*) (Figure 1, Appendix A.5). Refer Appendix A.5 for further discussion of EFH designated species life history descriptions and habitat requirements.

3.5.3 Benthic Resources

The NJDEP Division of Fish and Wildlife also includes macroinvertebrate studies in their biomonitoring program. A macroinvertebrate station, referred to as Ambient Biomonitoring Network (AMNET) station, is located in the same area as the fish survey station (Figure 2, Appendix A.1). Macroinvertebrates collected at the AMNET survey station (ANO195) by NJDEP BFBM in their most recent survey include freshwater oligochaete worms (*Nais*) non-biting midge (*Cryptochironomous*), (*Cricotopus*), ((*Polypedilum*), (*Rheotanytarsus*) (*Tanytarsus*), freshwater crustacean (*Gammarus*), (*Caecidotea*) water beetles (*Stenelmis*), caddisfly (*Hyrdroptila*), freshwater worm (*Prostoma*), and mayfly (*Slavina*). The dominant species collected (*Nais, Cricotopus, Polypedilium* and have a moderate to high tolerance to pollution (Miller 2012).

The District conducted a monitoring effort in fall of 2003 & 2004 prior to initiating the construction of the Joseph Medwick Memorial Park wetland mitigation site. Species caught included ribbed mussel (*Guekensia demissa*), salt marsh snail (*Melampus bidentatus*), and mud dog whelks (*Ilynassa* sp.). Although not caught, fiddler crab burrows were observed (USACE, December 2004)

The USACE also conducted spring and fall benthic surveys of the Rahway River within the project area in 2002. Grass shrimp (*Hippolytes* spp.) were the dominant shellfish species, followed by blue crab (*Callinectes sapidus*). In addition, fiddler crab burrows were observed on the marsh (USACE, March 2004).

3.5.4 Birds

The project area lies within the Atlantic Flyway, which is a migration route for over 400 bird species. Spring and fall avian surveys were conducted in the project area by the District in 2001 as part of an ecosystem restoration study. A total of 71 different bird species were identified by the surveys. The most abundant species encountered during USACE surveys were habitat generalists that are tolerant of the disturbance and fragmented habitats found in developed urban environments. A table of the species observed is included in Appendix A.1.

Bird surveys conducted from December 2012 through November 2013 by the National Audubon Society at the Hawk Rise Sanctuary located on the left bank of the Rahway River in Linden identified a total of 120 bird species utilizing the sanctuary (Munafo and Allen, 2013).

The open water and intertidal areas in the lower portion of the Rahway River provide feeding, resting, and brood-rearing habitat for a number of waterfowl, gulls, and wading birds. The most common species observed in these habitats include Canada goose (*Branta canadensis*), snowy egret (*Egretta thula*), double crested cormorant (Phalacrocorax auritus), great egret (Casmerodius

albus), greater black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), killdeer (*Charadrius vociferous*), mallard duck (*Anas platyrhynchos*), ring-billed gull (*Larus delawarensis*) (USACE, 2004).

Additionally, the forest scrub-shrub, herbaceous/scrub-shrub, and grass areas provide habitat for a wide range of resident and migratory passerines. Examples of the most commonly observed avian species utilizing these habitat types include generalists adapted for urban environments such as American robin (*Turdus migratorius*), Canada goose, common grackle (*Quiscalus quiscula*), European starling (*Sturnus vulgaris*), gray catbird (*Dumetella carolinensis*), house sparrow (*Passer domesticus*), mourning dove (*Zenaida macroura*), and rock dove (*Columbia livia*). Species commonly found in Phragmites-dominated portions of the project area include marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), and song sparrow (*Melospiza melodia*).

The portion of the Rahway River from Lenape Park in Cranford Township to the confluence with the Arthur Kill is a part of the Arthur Kill Complex and Tributaries Important Bird Area (IBA) as designated by the National Audubon Society. IBA's are sites that support habitat necessary for breeding, overwintering or migration and the goal of the IBA Program is "to stop habitat loss by setting science-based priorities for habitat conservation and promoting positive action to safeguard vital bird habitats." The National Audubon Society considers the Arthur Kill Complex and Tributaries IBA important due to the extensive habitat located in a densely urbanized region (National Audubon Society, 2017).

3.5.5 Mammals

Site specific surveys to document mammal species have not been conducted. However, given the level of urbanization within the majority of the project area, species expected to occur within the are those that are adapted to urban environments. Such species would include raccoon (*Procyn lotor*), chipmunk (*Tamias striatus*), red fox (*Vulpes vulpes*), woodchuck (Marmota monax), and muskrat (*Ondatra zibethicus*), eastern gray squirrel (*Sciurus carolinenensis*); opossum (*Didelphis marsupialis*)

White tail deer (*Odocoileus virginianus*) are known to occur within the Hawk Rise Sanctuary, as evidenced by the ongoing deer management program operated by Union County within the sanctuary (Rubino, 2017). Deer have also been observed at the Joseph Medwick Memorial Park during site investigations.

3.5.6 Reptiles and Amphibians

Site specific surveys were not conducted to identify reptile and amphibian species. However, species that could be expected to occur in the project area include bullfrog (*Rana catesbeiana*), Fowler's toad (*Bufo woodhousii fowleri*), eastern box turtle (*Terrapene Carolina*), snapping turtle (*Chelydra serpentine*), eastern garter snake (*Thamnophis sirtalis sirtalis*), northern water snake (*Nerodia sipedon*), eastern painted turtle (*Chrysemys picta*), eastern redback salamander (*Plethodon cinereus*).

3.6 Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) requires a Federal agency to ensure that any action authorized, funded or carried out by the agency does not jeopardize the continued existence of Federally-listed endangered and threatened species or result in the destruction or adverse modification of designated critical habitat of the Federally-listed species. The U.S. Fish and Wildlife Service and NOAA-NMFS maintain jurisdiction over Federally-listed species.

State-listed endangered, threatened and special concern species are protected under the New Jersey Endangered Species Conservation Act of 1973.

3.6.1 Federal Endangered, Threatened and Special Concern Species

United States Fish and Wildlife (USFWS) Trust Species

Based on an official Endangered and Threatened species list the District obtained from the U.S. Fish and Wildlife Service, there is the potential for the endangered Indiana bat (*Myotis sodalis*), and threatened northern long eared bat (*Myotis septentrionalis*) to occur within the project area (USFWS, 2017a).

Information provided in the list was further supplemented by a review of the "New Jersey Municipalities with Hibernation or Maternity Occurrence of Indiana bat or Northern Long-eared bat" list (USFWS, June 2016). Based on this list, several municipalities located in Union County have known Indiana bat and/or northern long-eared bat maternity colonies. These municipalities the Townships of Millburn, Berkeley Heights, New Providence and Scotch Plains, the Borough of Mountainside Borough and City of Summit. There are no known hibernaculums for either species in Union County.

There are no known occurrences of maternity colonies or hibernaculums for either species in Middlesex County.

Brief descriptions of the species' habitat preferences are below:

Indiana bat

Indiana bats spend the winter hibernating in caves and mines; with hibernation beginning in late October and emergence occurring typically in April. The Hibernia Mine located in Hibernia, NJ is a known Indiana bat hibernaculum and is located approximately 21 miles from the project area.

During the summer months, numerous female bats roost together in maternity colonies under the loose bark of dead or dying trees within riparian, flood plain and upland forests. Maternity colonies use multiple roosts in both living and dead trees. Adult males usually roost in trees near maternity roosts, but some males remain near hibernaculum.

Tree species commonly used as roost sites include American elm (*Ulmus Americana*), slippery elm (*Ulmus rubra*), shagbark hickory (*Carya ovata*) silver maple (*Acer saccharinum*), and green ash (*Fraxinus pennsylanica*). Adult males usually roost in trees near maternity roosts, but some remain near the hibernaculum.

Preferred foraging areas are streams, associated flood plain forests, and impounded bodies of water such as ponds and reservoirs. However, they have been observed in upland forests, pastures and clearings with early successional vegetation, cropland borders, and wooded fencerows (USFWS 2007).

Northern Long-Eared Bat

Similar to the Indiana bat, northern long-eared bats hibernate in caves and abandoned mines, with hibernation generally beginning in October/November and emergence typically occurring in April. Northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live and dead trees. Unlike Indiana bats, northern long-eared bats have also been observed in manmade structures such as buildings, barns, sheds, cabins, under eaves of buildings and bat houses. Preferred foraging areas are in forested habitats. (USFWS, 2015)

No other federally endangered or threatened species were identified in the list. The list is located in Appendix A.3 of the report.

The USFWS listed the rusty patched bumblebee (*Bombus affinis*) as endangered under the Endangered Species Act on January 17, 2017. However, based on a Draft Fish and Willdlife Coordination Act Report prepared for the Rahway River Basin Flood Risk Management Study, it is presumed that this species is extirpated in New Jersey although more research and field studies are warranted in the state (USFWS, 2017b).

In addition, the USFWS is currently evaluating the little brown bat (*Myotis lucifugus*), and the tricolored bat (*Perimyotis subflavus*) to determine if listing under the Endangered Species Act (ESA) is warranted (USFWS, 2017b).

Studies conducted by the New Jersey Department of Environmental Protection Division of Fish and Wildlife (NJDEP DFW) in 2016 identified two active American bald eagle nests; one in Linden and one in Kearny, approximately two miles from the project area (Smith and Clark, 2016). Although the bald eagle was removed from the Federal List of Endangered and Threatened Wildlife in 2007, it remains protected through the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

NOAA-NMFS Trust Species

A list of endangered species under the jurisdiction of the NOAA-NMFS Greater Atlantic Regional Fisheries Office is included in Appendix A.1 Environmental Documentation. The District consulted the Estimated Range Maps of each listed species located at the Greater Atlantic Regional Fisheries Office website to determine the potential occurrence of listed species within the project area. Based on a review of the Estimated Range Maps, the project area is within "Accessible Waterways" for both shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (NOAA-NMFS, May 2017a; NOAA-NMFS, May 2017b). A review of the Atlantic Sturgeon Proposed Critical Habitat maps did not indicate that the project area is considered critical habitat (NOAA-NMFS, May 2017c). The Estimated Range Maps for the shortnose and Atlantic sturgeon are located in Appendix A.1.

Brief descriptions of the species' habitat preferences are below:

Shortnose Sturgeon

Shortnose sturgeon is an anadromous species that inhabit rivers and estuaries. They spawn in the coastal rivers along the east coast of North America from the St. John River in Canada to the St. Johns River in Florida. They prefer the nearshore marine, estuarine, and riverine habitat of large river systems and do not appear to make long distance offshore migrations. Shortnose sturgeon, Preferred food sources include crustaceans, mollusks, and insects (NOAA-NMFS, 2017d)

Atlantic Sturgeon

Atlantic sturgeon are an anadromous species that spawn in freshwater in the spring and early summer and migrate into estuarine and marine waters where they spend most of their lives. They spawn in moderately flowing water (46-76 cm/s) in deep parts of large rivers. Sturgeon eggs are highly adhesive and are deposited on bottom substrate, usually on hard surfaces (e.g., cobble). Once larvae begin migrating downstream they use benthic structure (especially gravel matrices) as refuges. Juveniles usually reside in estuarine waters for months to years.

Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10-50 m depth) nearshore areas dominated by gravel and sand substrates. Long distance migrations away from spawning rivers are common. Preferred food sources are worms, mollusks and crustaceans (NOAA-NMFS, 2017e).

3.6.2 State Endangered, Threatened and Special Concern Species

A review of the New Jersey geo-web database indicated that the large wetland complex located on the left bank of the Rahway River near and at the Hawk Rise Sanctuary has documented foraging activity by state special concern species such as little blue heron (*Egretta caerulea*), snowy egret (*Egretta thula*), tricolored heron (*Egretta tricolor*), and glossy ibis (*Plegadis falcinellus*), and state threatened species including black-crowned night heron (*Nycticorax nycticorax*), cattle egret (*Bubulcus ibis*), and yellow-crowned night heron (*Nyctanassa violacea*). A breeding sighting of the state endangered northern harrier (*Circus cyaneus*) state endangered occurred within this wetland complex.

The wetland complex located within the Joseph Medwick Memorial Park has documented foraging activity by cattle egret, snowy egret, black-crowned night heron, little blue heron and glossy ibis.

State endangered, threatened or special concern species observed during surveys conducted at the Hawk Rise Sanctuary from 2010 through 2013 are listed in the below tables (Munafo and Allen, 2013).

Table 13. State Endangered Bird Species Observed at Hawk Rise Sanctuary

Latin Name	Common Name
Ammodramus savannarum	Grasshopper sparrow
Haliaeetus leucocephalus	American bald eagle
Pandion haliaetus	Osprey

Passerculus sandwichensis	Savannah sparrow
Rynchops niger	Black skimmer

Table 14: State Threatened Bird Species Observed at Hawk Rise Sanctuary

Latin Name	Common Name
Circus cyaneus	Northern harrier
Dolichonyx oryzivorus	Bobolink
Falco peregrinus	Peregrine falcon
Falco sparverius	American kestrel

Table 15: State Special Concern Bird Species Observed at Hawk Rise Sanctuary

Latin Name	Common Name
Accipiter cooperii	Cooper's hawk
Accipiter striatus	Sharp-shinned hawk
Actitis macularius	Spotted sandpiper
Ardea Herodias	Great blue heron
Calidris pusilla	Semipalmated sandpiper
Cardellina Canadensis	Canada warbler
Catharus fuscescens	Veery
Egretta thula	Snowy egret
Empidonax minimus	Least flycatcher
Hylocichla mustelina	Wood-thrush
Icteria virens	Yellow-breasted chat
Oreothylpis ruficapilla	Nashville warbler
Setophaga caerulescens	Black-throated blue warbler
Setophaga virens	Black-throated green warbler
Sturnella magna	Eastern meadowlark
Toxostoma rufum	Brown thrasher
Troglodytes hiemalis	Winter wren

As discussed in Section 3.6.1, two bald eagle nests are located within two miles of the project area based on surveys conducted by the NJDEP DFW.

3.7 Socioeconomics

3.7.1 Demographics and Economy

Rahway

The 2010 U.S. Census listed the City of Rahway's population as 27,346, reflecting an increase of 846 (+3.2%) from the 26,500 counted in the 2000 U.S. Census. The U.S. Census 2009-2013 American Community Survey 5-Year Estimates lists 10.9% of the city as below the poverty line.

Linden
The 2010 U.S. Census listed the City of Linden's population as 40,499, reflecting an increase of 1,105 (+2.8%) from the 39,394 counted in the 2000 U.S. Census. The U.S. Census 2011-2015 American Community Survey 5-Year Estimates lists 9.4% of the city as below the poverty line.

Approximately 13% of Linden's population are seniors (65 years and older); a third of those seniors live alone and 75% of seniors living alone are widowed/single women. Approximately 9.1% of seniors in Linden are below the poverty level. Almost a quarter of Linden's senior residents do not have access to a vehicle. Just under 8% of the population under 65 years are classified as disabled.

Carteret
The 2010 U.S. Census listed the Borough of Carteret's population as 22,844, reflecting an increase of 2,135 (+10.3%) from the 20,709 counted in the 2000 U.S. Census. The U.S. Census 2011-2015 American Community Survey 5-Year Estimates lists 15.1% of the borough as below the poverty line.

Eleven percent of the population is 65 year and older. More than a quarter of these seniors live alone and have an annual income of $20,000. Two-thirds of the seniors living alone are widows/single women. Approximately 83% of the seniors own their own home. Overall, 19% of the senior households in Carteret do not have access to a vehicle. 11.4% of seniors live below the poverty line. Approximately 5.6% of the population under 65 years is classified as disabled.

Woodbridge
The 2010 U.S. Census listed the Township of Woodbridge's population as 99,585, reflecting an increase of 2,382 (+2.5%) from the 97,203 counted in the 2000 U.S. Census. The U.S. Census 2011-2015 American Community Survey 5-Year Estimates lists 6.3% of the township as below the poverty line.

Twelve percent of the population of Woodbridge are seniors. A third of those seniors live alone and a quarter of seniors have an annual income of less than $20,000. Of the seniors living along, 74% are widows/single women. Twenty-six percent of seniors rent their home. Thirteen percent of Woodbridge senior households do not have access to a vehicle. 6.2% of seniors live below the poverty line. Approximately 5.8% of the population under 65 years is classified as disabled.

Union and Middlesex County
The 2010 U.S. Census listed the County of Union's population as 536,499, reflecting an increase of 13,958 (+2.7%) from the 522,541 counted in the 2000 U.S. Census. The U.S. Census 2011-2015 American Community Survey 5-Year Estimates lists 10.9% of the county as below the poverty line.

The 2010 U.S. Census listed the County of Middlesex's population as 809,858, reflecting an increase of 56,696 (+8.0%) from the 750,162 counted in the 2000 U.S. Census. The U.S. Census

2009-2013 American Community Survey 5-Year Estimates lists 8.8% of the county as below the poverty line.

It is apparent from the above statistics that population in the Cities of Rahway and Linden, the Township of Woodbridge and the County of Union have increased at a slow, steady rate or remained relatively constant between 2000 and 2010. Population has increased at a greater rate in the Borough of Carteret and the County of Middlesex. The Borough of Carteret has the greatest poverty rate while the Township of Woodbridge the least. All are developed suburban municipalities with residential, commercial and industrial facilities and relatively little undeveloped open space. Therefore it is assumed that impervious surface cover and land use trends will not significantly change over the lifespan of a potential project.

Economy

The majority of land in the immediate project area contains residential, commercial and industrial development. The local commercial and industrial facilities in the area represent an important regional commercial resource.

The City of Rahway has seen the rise of service-dependent jobs within its borders and growth in finance, pharmaceuticals and telecommunications throughout the region as Rahway residents traveled throughout New Jersey and New York for employment.

The east side of Linden is located along Arthur Kill. The Arthur Kill plays an important role in bulk cargo transportation in the Port of New York and New Jersey. Along with Elizabeth, Linden is home to the Bayway Refinery, a refining facility that helps supply petroleum based products to the New York and New Jersey area, producing approximately 230,000 barrels per day. Linden, together with Rahway, is home to Merck & Company, one of the world's leading pharmaceutical companies.

The Township of Woodbridge is home to a large shopping mall.

3.7.2 Environmental Justice

The Environmental Protection Agency defines Environmental Justice as the “fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development implementation and enforcement of environmental laws, regulations and polices. Fair treatment means no group of peoples should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies”

Executive Order 12898, Federal Actions to address Environmental Justice in Minority and Low Income Populations mandates that each federal agency identify and address potential disproportionately high and adverse effects of its activities, programs, and policies on minority populations and low income populations. Specifically, the adverse effects pertain to human health, and the environment must be identified and addressed. According to EO 12898, minority populations exist where the percentage of minorities exceeds 50% or where the minority population percentage in the affected area is meaningfully greater than in the general population.

EO 12898 does not provide criteria to determine if an affected area consists of a low-income population.

A cursory analysis was conducted to determine the potential applicability of Environmental Justice issues. The analysis took into account a comparison of the percentage of low income and minority populations occurring in each municipality within the Counties in which they are located. Those municipalities where the combined minority populations and/or the low income populations are higher than the County would be subject to Environmental Justice considerations.

The combined minority population of Middlesex County is 52.8%. The percentage of individuals living below the poverty line is 8.8% and the percentage of families living below the poverty line is 6.4%.

Carteret Borough has a combined minority population of 65.8% which is higher than Middlesex County. In addition, the percentage of individuals and families living below the poverty level is greater than Middlesex County at 15.1% and 11.1% respectively.

Woodbridge Township has a combined minority population of 52.6% which is lower than Middlesex County. The percentage of individuals and families living below the poverty level is less than Middlesex County at 6.3% and 5.3% respectively.

Union County has a combined minority population of 55.7%. The percentage of individuals living below the poverty level is 10.9% with the percentage of families living below the poverty level is 8.6%.

The City of Linden has a combined minority population of 60.8%. The percentage of individuals living below the poverty level is 9.4% with the percentage of families living below the poverty level is 7.4%.

The City of Rahway has a higher combined minority level than Union at 62.7%. The percentage of individuals living below the poverty level is 8.5% with the percentage of families living below the poverty level at 6.8%

3.8 Hazardous, Toxic and Radioactive Waste

Using Federal and state environmental databases, an inventory of known locations with contaminated soils and impacts to groundwater was prepared. This inventory covers the portion of the lower Rahway River from its confluence with the Arthur Kill upstream to the limits of tidal influence within the City of Rahway. The research area encompassed the 100 year floodplain and included portions of the Cities of Linden and Rahway in Union County and the Borough of Carteret, Middlesex County.

Databases consulted included the following:

- National Priority List (NPL)
- Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

- State Known Contaminated Sites List (KCS)

This research indicated that within the study area there is one EPA Superfund site, LCP Chemicals, located in Linden nearby on the Arthur Kill (Figure 7). There are no other Superfund sites within the study area.

The NJDEP KCS lists active sites as those sites having one or more active cases or remedial action permits where contamination has been confirmed. The KCS list also identifies pending sites for which remedial actions have not been undertaken. For the portions of Rahway, Linden and Carteret within the current study area, a review of the NJDEP KCS list identified: 1) 41 active sites and seven pending sites for Rahway; 2) 26 active and four pending sites for Linden; and 3) 18 active and one pending sites for Carteret (see Figure 7). These sites consist of gas stations or other sites that have gasoline storage for vehicles, dry cleaners, mechanic shops, and light manufacturing. Sites along the Arthur Kill are associated with large-scale industrial chemical and fuel oil storage commercial activities.

As part of the New York – New Jersey Harbor Deepening Project, the District utilized a portion of Joseph Medwick Memorial Park for salt marsh restoration to mitigate impacts caused by the deepening project. At the site of a planned observation deck for park users, the District encountered industrial debris consisting of drums of pesticides. The soil around the debris was also found to be contaminated with pesticides and heavy metals, specifically lead and arsenic. As part of the upgrade for the 83-acre park, Middlesex County remediated and cleaned up the contamination prior to the construction of new football, soccer and multi-purpose fields as well as two baseball fields.

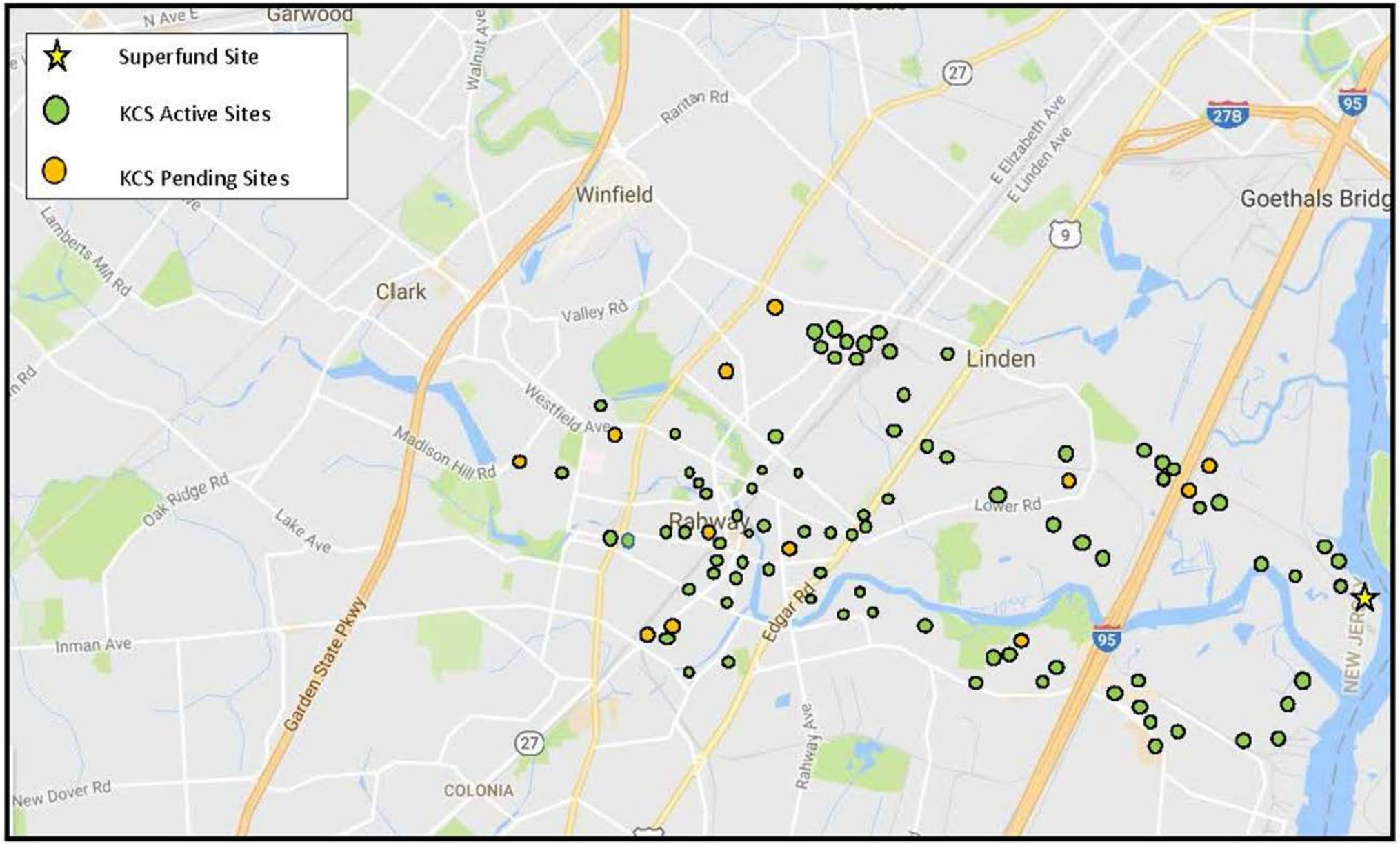


Figure 7. Map Showing the Location of the Pending and Active KCS in the Rahway, Linden and Carteret Study Areas

3.9 Cultural Resources

As an agency of the federal government, the U.S. Army Corps of Engineers has certain responsibilities concerning the protection and preservation of historic properties. Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, the Advisory Council on Historic Preservation's Procedures for the Protection of Historic and Cultural Properties (36 CFR 800), and Executive Order 11593 direct federal agencies to take into account the effect of any undertaking on historic properties included on, or eligible for, the National Register of Historic Places (NRHP). In accordance with these guiding regulations, the District carried out a preliminary cultural resources investigation of the study area to identify previously documented historic properties and archaeological sites and initiated coordination with the New Jersey State Historic Preservation Office, the Federally Recognized Tribes, and local interested parties (Scarpa 2017).

Seven archaeological sites have been documented within the study area, three contained pre-contact materials and all seven contained a historic component as well (See Table 16)

Table 16. Archaeological Sites in the Study Area

Site #	Site Name	Muni.	Period	Source
28-UN-13	Edgar Farm Site	Rahway	19th Cent. and Prehistoric	NJDOT, 1984
28-UN-38	River View Manor, historically known as the Dolbier-Housman House	Rahway	1800's	Maser Consulting, 2006
28-UN-51	King's Creek	Linden	Pre-contact and Post-contact	PAL, Inc., 2011
28-UN-53	Tremley Site	Linden	Middle to Late Woodland and early-mid twentieth century	PAL, Inc. 2011
28-UN-40	Rahway City Hall-Municipal Building Historic Site	Rahway	1800-20th Century	CRCG, 2007
28-UN-41	Historic House Site Lot 3	Rahway	1800-20th Century	CRCG, 2007
28-UN-42	The Peace Tavern-Woodruff Historic House Site	Rahway	1800-20th Century	CRCG, 2007

Nine historic districts have been documented within the study area: 1) the Upper Rahway Historic District; 2) the Rahway River Parkway Historic District; 3) the Union County Park System Historic District; 4) the Lower Rahway/Main Street Historic District; 5) the Regina Historic District; 6) the Pennsylvania Railroad New York to Philadelphia Historic District; 7) the Perth Amboy and Elizabethport Branch of the Central Railroad of New Jersey Historic District; and 8) the Sound Shore Railraod Historic District; and 9) the Inches Line Linear Multistate Historic District (See Figure 8).

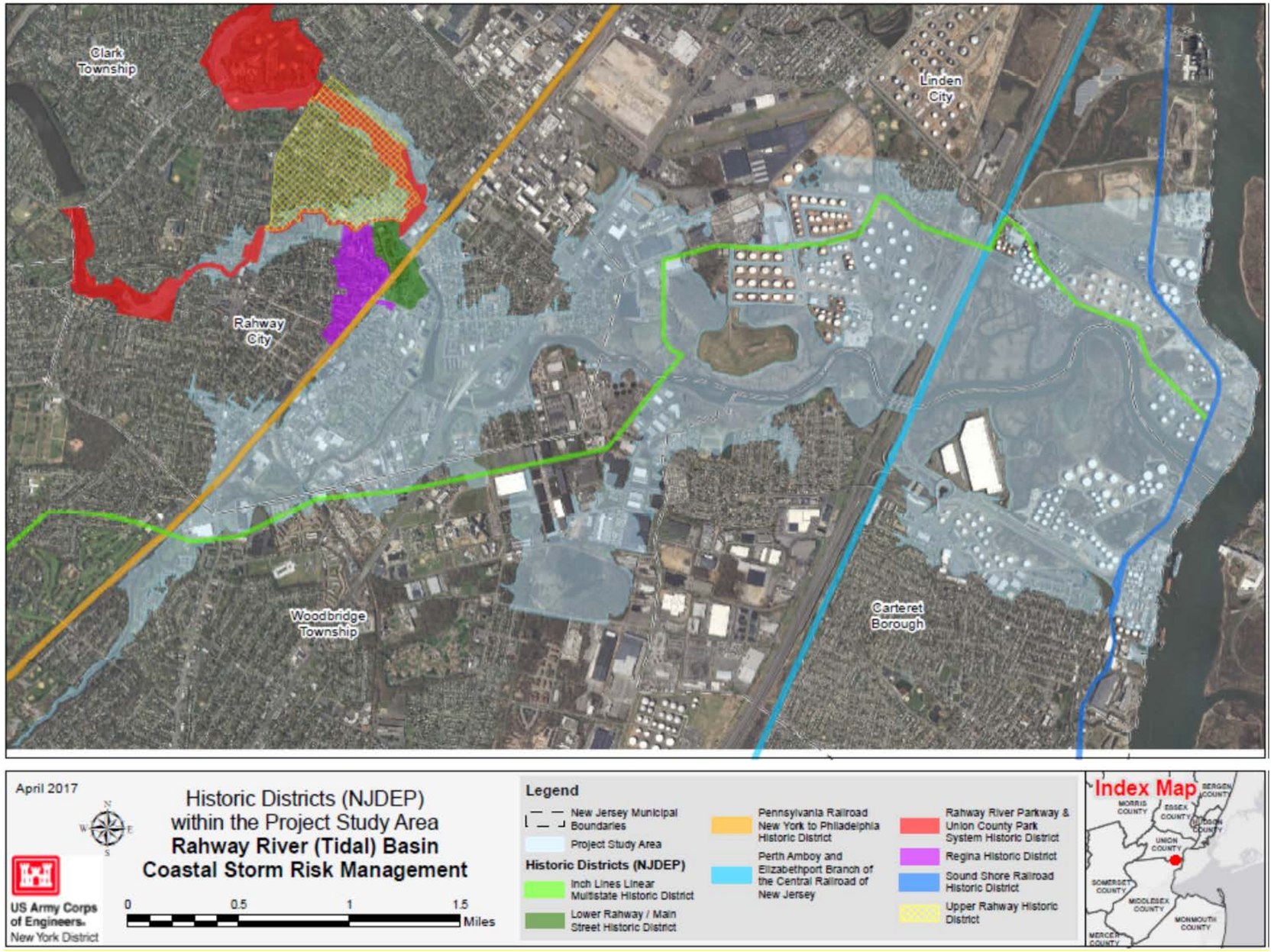


Figure 8. Upper Rahway Historic District

3.10 Recreation

Specific areas supportive of active and/or passive recreational activities within the project area include the Rahway Recreation Center, the Center Circle Indoor Sports facility, the Lower Essex Street park, Waterfront Park, Joseph Medwick Memorial Park, and Hawk Rise Sanctuary.

The Rahway Recreation Center is an indoor facility that provides space for concerts, arts and crafts and indoor sporting events such as volleyball. The Center Circle Indoor Sports facility is a large indoor structure utilized for soccer, lacrosse and other sporting events. The Lower Essex Street Park contains a paved walkway, exercise stations, benches and a pagoda with four benches.

The Joseph Medwick Memorial Park is an 88 acre park that contains picnic areas, a playgrounds, tennis courts, walking trails, athletic fields, a little league field and two wildlife observation decks overlooking tidal wetlands along the Rahway River.

The Hawk Rise Sanctuary is a 95 acre ecological preserve and wetland complex that was developed from a former landfill. The Sanctuary contains trails with interpretive signage, overlook decks and pedestrian bridges.

The Rahway River itself within the Study Area offers limited water based recreational opportunities due to a lack of public access points. A small marina owned by the Rahway Yacht club, which is privately owned is located on the left bank of the Rahway River approximately a half mile south of the Route 9 bridge.

3.10.1 Green Acres Program

The Green Acres Program, created in 1961 and administered by the New Jersey Department of Environmental Protection, provides funds for the State or local municipalities through financial assistance by the State, to acquire and maintain lands for the purposes of recreation. A review of the Green Acres Program Open Space Database indicates that the Lower Essex Street Riverfront Park located in the City of Rahway, the Hawk Rise Sanctuary located in the City of Linden and the Joseph Medwick Memorial Park located in the Borough of Carteret was acquired with Green Acres Program funds (Figure 9).

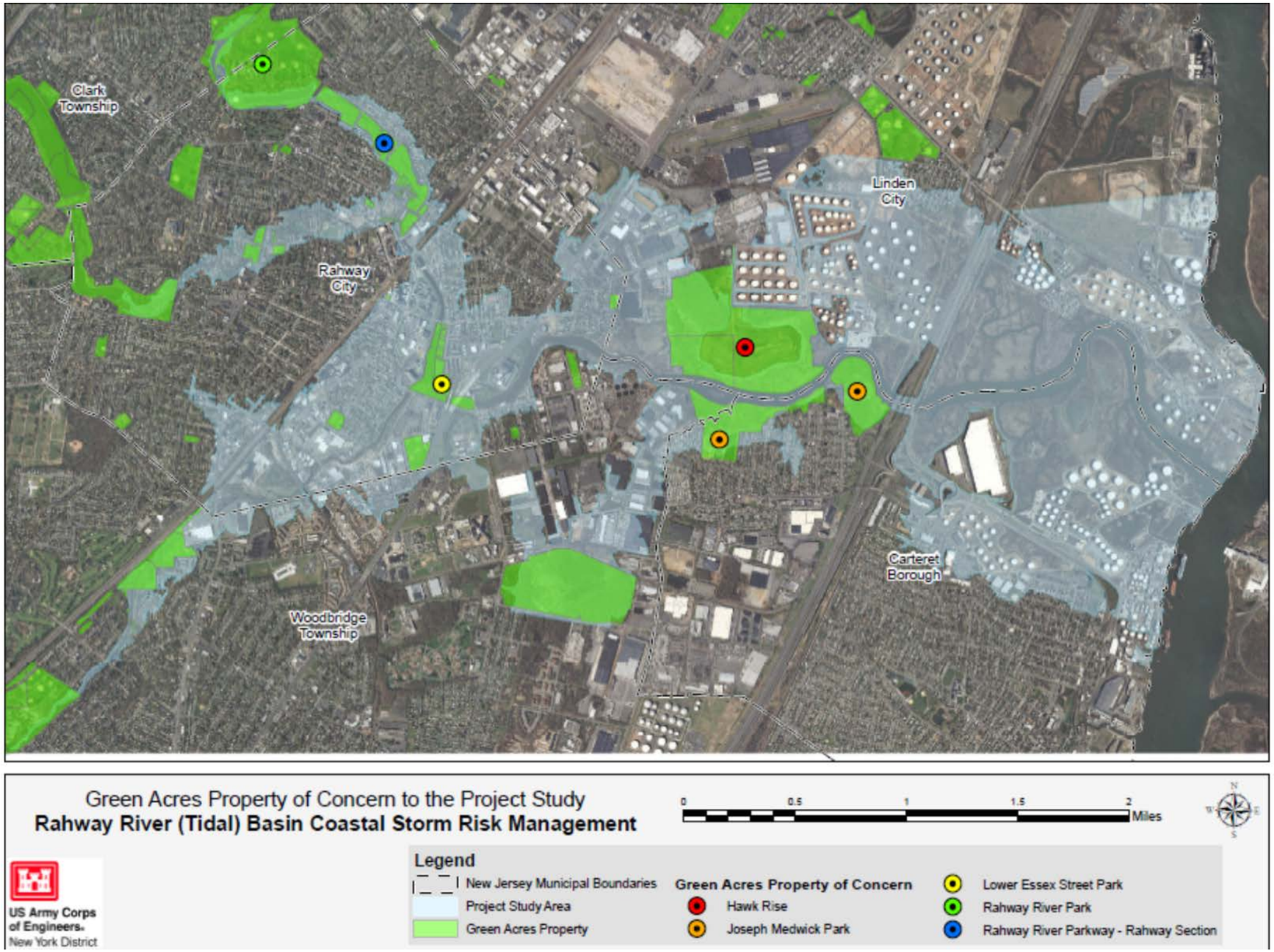


Figure 9. Green Acres Encumbered Lands Within the Project Area

3.11 Aesthetics and Scenic Resources

The aesthetic quality within the northern portion of the project area is influenced by heavy residential and business development. Much of the land along the river shorelines or wetland margins is developed with single-family residential dwellings and local business/industries. The visual setting of the project area is characterized by moderate to high-density development along the river and on the margins of the wetlands. The lower portion of the project area is characterized by tidal wetlands and industrial development. The left bank of the Rahway River south of the Route 9 bridge offers the greatest visual appeal in that view is comprised of approximately 2.5 miles of contiguous tidal marsh complexes. A portion of this viewshed is accessible from the Joseph Medwick Memorial Park, which is located on the right bank of the Rahway River.

There are no scenic byways, National Wildlife Refuges, National Parks, National Forests, National Natural Landmarks or National Heritage sites within one mile of the project area. Neither the Rahway River nor its associated tributaries within the project area are listed as wild, scenic or recreation rivers.

3.12 Coastal Zone Management

The Coastal Zone Management Act of 1972 (16 United States Code 1451-1464) was enacted by Congress to balance the demands for growth and development with the competing demands for protection of coastal resources. This act requires that federal activities affecting land or water resources located in the coastal zone be consistent to the maximum extent practicable with the federally approved state coastal zone management plans. This act is regulated in New Jersey by the New Jersey DEP, Division of Land Use Regulation. Local governments can participate in Coastal Zone Management compliance through the development of Municipal Public Access Plans (MPAPs). Municipalities within the project area that have prepared MPAPs include the Borough of Carteret and City of Linden.

New Jersey's coastal zone management program primarily derives its authority form three state statutes: The Waterfront and Harbor Facilities Act of 1914 (NJSA 12:5-3), the Wetlands Act of 1970 (NJSA 13:9A), and the Coastal Area Facility Review Act (CAFRA) (NJSA 13:19).

The Rahway River is not located within the region of New Jersey subject to the CAFRA. However, the lower portion of the Rahway River is subject to the regulations set forth in the Waterfront and Harbor Facilities Act of 1914. The District has prepared a feasibility level Statement of Compliance for Coastal Zone Management which is included in Appendix A.6.

3.13 Transportation

The study area is convenient to major population centers through a network of modern highways. Routes 1 and 9 run through the city and the Garden State Parkway and New Jersey Turnpike are located in very close proximity to the city line. These highways provide access to various northern and southern areas of the state as well as urbanized cities such as Newark and New York. The area is served by the busy Northeast Corridor and North Jersey Coast rail lines, linking Rahway with Newark, Manhattan, Trenton and the Jersey Shore. A significant part of the tidal portion of the Rahway River is navigable by small boat.

Access in and out of and through low-lying areas is limited during flooding events. Portions of the New Jersey Turnpike, Routes 1 and 9 and the New Jersey Transit rail lines are subject to coastal storm surge

inundation during storm events, blocking transit. Numerous local roads become inaccessible during storm events. Such conditions would be greatly improved with storm risk management improvements.

3.14 Air Quality

The Project area is located in Middlesex and Union Counties, New Jersey, which are part of the New York, Northern New Jersey, Long Island, and Connecticut ozone nonattainment area. These counties have been designated with the following attainment status with respect to the National Ambient Air Quality Standards (NAAQS) for criteria pollutants: 'moderate' nonattainment area for the 2008 8-hour ozone standard, maintenance area for the 2006 particulate matter less than 2.5 microns (PM2.5) standard, and Union County is a maintenance area for 1971 carbon monoxide (CO) standard (40 CFR §81.331). These counties are part of a larger Ozone Transport Region. Oxides of nitrogen (NOx) and volatile organic compounds (VOCs) are precursors for ozone, while sulfur dioxide (SO2) (commonly reported as sulfur oxides (SOx)) is a precursor pollutant for PM2.5. Union and Middlesex Counties are in attainment of the NAAQS for all other criteria pollutants.

Emissions from the project are associated with non-road construction equipment working on the site and on-road trucks moving on public roads to and from the Project site. Emissions from these two source categories, primarily generated from their diesel engines, include NOx, VOCs, SO2, CO, and PM2.5. Emissions from Federal Actions, such as the proposed project, are regulated under 40 CFR §93 Subpart B General Conformity, which aims to ensure that emissions from Federal Actions to not impede a State's progress toward achieving or maintaining compliance with NAAQS under their applicable State Implementation Plan (SIP). Fugitive dust on the worksite can potentially be generated due to trucks and equipment moving on unpaved surfaces, but can be significantly reduced through the use of best management practices relating to site work dust mitigation.

3.14.1 Green House Gases and Climate Change

In addition to the applicable regulated pollutants, each Federal Agency project's NEPA assessments will consider and evaluate greenhouse gases (GHGs) consistent with the final guidance on the consideration of GHGs emissions and the effects of climate change issued by the former administration's Council on Environmental Quality (CEQ). It is noted that this final guidance is no longer available on the current "whitehouse.gov" website (nor is anything related to the CEQ), but is posted on an archive website as footnoted below. The extent to which this guidance will be adopted by the current administration, if at all, is not known at this time.

3.15 Noise

Noise is generally defined as unwanted sound. The day-night noise level (Ldn) is widely used to describe noise levels in any given community (USEPA 1978). The unit of measurement for Ldn is the "A"-weighted decibel (Dba), which closely approximates the frequency responses of human hearing.

The primary source of noise in the project area is vehicular traffic on local roadways, local construction projects that may be underway, and operation of businesses. Although noise level measurements have not been obtained in the project area, they can be approximated based on existing land uses. The typical Ldn in residential areas similar to the project area ranges from 39 to 59 Dba (USEPA 1978). The project area is characterized as residential and business development, therefore existing sound levels are likely within this range.

Chapter 4.0 Plan Formulation

The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) laid out an iterative 6-step planning process used for all USACE Civil Works studies in developing and evaluation of alternatives. For flood risk management problems, the study team develops and evaluates potential alternatives consistent with USACE policy, regulations, and guidance. From the range of alternatives compared, the team will identify the plan with the highest net National Economic Development (NED) benefits while protecting the Nation's environment.

4.1 Problem and Opportunity Statement

The problem and opportunity statements and discussion provided below set the focus of the feasibility study. These statements are developed at the start of the study and lead to the identification of the study objectives.

Problem

The primary problem encountered in the study area is flooding with elevated water levels associated with coastal storm surge on the Rahway River and tributaries within the study area.

Storm Events

A number of storms, tropical storms, northeasters and hurricanes have caused coastal storm surge inundation and damage in recent decades. The most significant to this study are Hurricane Sandy & Tropical Storm Irene.

Hurricane Sandy: 22 – 29 October 2012

Hurricane Sandy initially formed as a tropical depression in the southwestern Caribbean. Sandy weakened somewhat and then made landfall as a post-tropical cyclone near Brigantine, New Jersey with 70-kt maximum sustained winds. Because of its extensive size Sandy drove a very severe storm surge into the New Jersey and New York coastlines.

The highest storm surge measured by a National Ocean Service (NOS) tide gauge in New Jersey was 8.57 feet above normal tide levels at the northern end of Sandy Hook in the Gateway National Recreation Area. Since the station failed and stopped reporting during the storm, it is likely that the actual storm surge was higher. Farther south, the NOS tide gauges in Atlantic City and Cape May measured storm surges of 5.82 ft and 5.16 ft, respectively.

The following inundations, expressed above ground level, were prevalent along the coast due to the storm tide:

Monmouth and Middlesex Counties	4 – 9 feet
Union and Hudson Counties	3 – 7 feet
Essex and Bergen Counties	2 – 4 feet
Ocean County	3 – 5 feet
Atlantic, Burlington, and Cape May Counties	2 – 4 feet

The highest storm surge occurred in areas that border Lower New York Bay, Raritan Bay, and the Raritan River. The highest high-water mark measured by the USGS was 8.9 ft above ground level at the U.S. Coast Guard Station on Sandy Hook. This high-water mark agrees well with data from the nearby NOS tide gauge, which reported 8.01 ft above mean higher high water (MHHW) before it failed. Elsewhere, a high-water mark of 7.9 ft above ground level was measured in Keyport on the southern side of Raritan Bay and a mark of 7.7 ft was measured in Sayreville near the Raritan River.

As storm surge from Sandy was pushed into New York and Raritan Bays, seawater surge occurred within the Hudson River and the coastal waterways and wetlands of northeastern New Jersey, including Newark Bay, the Passaic and Hackensack Rivers, Kill Van Kull, and Arthur Kill. Significant inundations occurred along the Hudson River in Weehawken, Hoboken, and Jersey City, where many high-water marks indicated that inundations were between 4 and 6.5 ft above ground level. Inundations of 4 to 6 ft were also measured across Newark Bay in Elizabeth and the area around Newark Liberty International Airport.

Conversation between Corps and the Middlesex Office of Emergency Management (OEM) revealed that municipalities within the lower portion of the Rahway River Basin and general area suffered coastal storm surge induced flood damages from Sandy. It is estimated that Hurricane Sandy caused tens of millions of dollars of damage in the study area. The City of Rahway sustained an estimated $35 million in damages with approximately $15 million of it to city property and another $20 million to private property. Damages included costly repairs to the existing Corps levee pump stations. Damages for the Borough of Carteret are estimated at $53.1M. Woodbridge Township suffered damages estimate at $7M with 200 structures damaged, including 40 destroyed. The PSE&G power plant in Woodbridge was destroyed. Blue Acres at the NJDEP is in the process of buying out 175 structures in the township.

During Hurricane Sandy, bulk fuel tanks were damaged and fuel flowed into the Arthur Kill. The storm temporarily shut down oil refineries in the study area leading to shortages of fuel in northern New Jersey. No deaths linked with Hurricane Sandy have been identified within the study area.

Tropical Cyclone Irene: Storm of 27-28 August 2011

Irene made its United States landfall near Little Egg Inlet, New Jersey on Sunday, August 28, 2011 as a hurricane with maximum sustained winds of 75 mph. At this point Irene had weakened to a tropical storm. Tropical Storm Irene produced about three to 13 inches of rain on the watersheds within the New York District's civil works boundaries in northern New Jersey and southern New York in about a 16 hour period between Saturday, August 27 and Sunday, August 28. Tropical Storm Irene rainfall total for the Rahway River basin was about 10 inches. Irene generated a storm surge of 4 to 6 feet along the New Jersey coast and a surge of 3 to 6 feet in the New York City and Long Island areas.

Other Storm Events

Various other storms, tropical storms, northeasters and hurricanes caused coastal storm surge inundation and damage in recent decades. These include:

- Storm of 15-16 April 2007
- Tropical Storm Floyd on 15-16 September 1999
- Storm of October 19 1996

- Northeaster Storm of 11-12 December, 1992
- Halloween Northeaster of 31 October 1991
- Hurricane Gloria on 27 September 1985
- Coastal Storm of 29-30 March 1984.
- Tropical Storm Doria 26-28 August 1971
- Coastal Storm of 6-8 March 1962
- Hurricane of 12 September 1960 (Donna)
- Storm of 6-7 November 1953
- Storm of 25 November 1950
- Hurricane of 14 September 1944

Opportunity

There are opportunities in the lower portion of the Rahway River Basin affected by coastal storm surge to:

- Decrease risk of damages to structures and roadways due to flooding from coastal storm surge.
- Reduce risks to life and public safety due to coastal storm flooding from coastal storm surge.
- Improve public awareness of coastal storm risks.
- Develop a coastal storm risk management plan that complements regional economic development planning.

Opportunities exist for the development of feasibility-level plans for the study area, which could complement and enhance regional plans for economic development. The NJDEP and the City of Rahway have indicated a desire for coastal storm risk management.

Figure 10. Flooding Within the Project Area

4.2 Planning Goals/Objectives

Study goals and objectives were developed to comply with the study authority and to respond to study area problems. Planning objectives were identified based on the problems, needs and opportunities as well as existing physical and environmental conditions present in the study area. The main goal is Contribute to National Economic Development (NED) by reducing the frequency and severity of coastal storm surge flood damages within the study area, consistent with the nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. The main Federal objective is to reduce the risk of coastal storm surge flood damages within the project area, lying within portions of the municipalities of Carteret, Linden, Rahway and Woodbridge. Recommended plans should avoid, minimize, and then mitigate, if necessary, adverse project impacts to the environment. They should also avoid adverse social impacts and meet local preferences to the fullest extent possible.

All alternatives were evaluated against four planning and guidance criteria: 1) *acceptability*, the workability and viability of the alternative plan with respect to acceptance by Federal and non-Federal entities and the public and compatibility with existing laws, regulations, and public policies; 2) *completeness*, the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects; 3) *effectiveness*, the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities; and 4) *efficiency*, the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment. Coordination is ongoing through this study with the non-Federal sponsor, other agencies and local stakeholders to help ensure acceptability of the TSP and the suite of alternatives. Plans were formulated to be complete, effective and efficient through economic, engineering and environmental analysis. The plan selection process assisted in promoting efficiency by identifying the TSP as the plan that maximized net benefits among the suite of alternatives.

The goals and objectives of this study are:

Goals

- Contribute to National Economic Development (NED) by reducing the risk of coastal storm surge flood damage.
- Reduce the risks to life safety within the study area.
- Provide a plan that is compatible with future coastal storm risk management and economic development opportunities.
- Where possible coastal flood risk management alternatives should benefit environmental resources.

Objectives

- Reduce the risk of damages to property and dangers to life safety resulting from coastal storm surge flooding within the project area, lying within portions of the municipalities of Carteret, Linden, Rahway and Woodbridge.
- Increase public awareness to the risk of flooding from the Rahway River.

4.3 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. Further, plan formulation must provide safe conditions in the

interest of public safety and be socially acceptable to the community. Planning constraints considered to this point are as follows:

Universal Constraints

- **Flood Heights:** Avoid or minimize inducing additional flood damages to any areas beyond the limits of the Coastal Storm Risk Management Project (ER 1165-2-26).

- **Environmental and Cultural Resources:** Alternatives should be designed to avoid or minimize negative impacts to these resources, to the maximum extent practical.

Study Specific Constraints

- **Navigation Channel:** The Arthur Kill contains a navigation channel for large ships that would preclude implementation of structural measures in the Arthur Kill itself.

- **Industrialized Shoreline:** The shoreline and area directly inland of the Arthur Kill are highly industrialized and no room exists for structural measures.

- **Green Acres:** Lower Essex Street Riverfront Park located in the City of Rahway, the Hawk Rise Sanctuary located in the City of Linden, and the Joseph Medwick Memorial Park located in the Borough of Carteret were acquired with Green Acres Program funds for recreation and conservation purposes. These properties are encumbered to permanently remain in use for recreation and conservation purposes. Plan formulation will avoid these areas to the extent practicable and minimize and mitigate for any project impacts in compliance with the New Jersey Green Acres Program regulations.

Considerations

- **Cultural Resources:** There are existing previously identified National Register of Historic Places (NRHP) listed or eligible historic properties within the study area. Impacts to these resources must be taken into consideration when formulating alternatives with the understanding that additional investigations must be carried out following selection of an alternative to determine the presence or absence of previously unidentified historic properties and archaeological sites within the project area. A Programmatic Agreement will be prepared to identify mitigation for adverse impacts, in consultation with the New Jersey Historic Preservation Office and other interested parties.

- **HTRW:** The chemical facilities and petroleum refineries along the right and left banks of the Rahway River in Carteret and Linden in the vicinity of the Arthur Kill are active and have ongoing HTRW issues that would make implementation of a structural solution difficult along the Arthur Kill and Rahway River in that direct vicinity.

- **Models:** The District will coordinate with the relevant Center of Expertise (PCX) on the use of certified models. As stated in Section 10.3, the District will use ecological models that have already been approved or certified for use by the Corps Ecosystem Restoration Center of Expertise (ECO-PCX) to quantify impacts.

4.4 Future Without Project Condition

The future without project condition serves as the base condition to use as a comparison for all the other alternatives. The future without project condition within the period of analysis (2021-2071) are identified as continued damages to structures, content, vehicles, infrastructure, life safety and quick access to emergency services from future storm events. This will result in continued maintenance and reconstruction of private armoring (bulkheads) and repairs to houses and roads following storm events.

4.4.1 FWOP/ No Action Plan

The future without project condition serves as the base condition to use as a comparison for all other alternatives. The future without project condition within the period of analysis is identified. Relevant resources of the area and the No Action alternative are succinctly described as required by NEPA. The No Action alternative and the plan formulation "Future Without-Project" setting are equivalent.

Land Use

In the short-term, selecting the No Action alternative would not change land use, land cover and zoning in the project area. However, in the long term, coastal storm surge flood damage to properties abutting the Rahway River and its tributaries, particularly in flood prone areas, are likely to sustain continued damage during future storm events. Without proactively addressing coastal storm surge flood risks, costly damages will continue to accrue and some businesses and residences may eventually be abandoned, property values may decrease, or development may be prohibited, all of which could lead to changes in land use, cover or zoning.

4.4.2 Environmental Without Project Conditions

Topography, Geology and Soils

The No Action alternative would not result in any change to the topographic and geologic resources within the project area. However, without any flood improvements, flooding, erosion, sedimentation and scour will continue in the long-term.

Water Resources

Under the No Action alternative, water quality and habitat would remain unchanged unless others take restorative actions to enhance aquatic habitat and water quality. In addition, there will be no changes to wetland communities within the project area.

Vegetation

The No Action alternative would have no effect on the plant communities that occur within the project area. There are no short or long-term disturbance to any vegetation and thus upland and wetland communities would remain as they are expect for changes associated with natural disturbance events – including future flooding events- and community succession.

Fish and Wildlife

Under the No Action alternative, fish and wildlife utilization of the project areas will be consistent with current conditions. The same is true for any state and/or federal endangered, threatened or special concern species that may occur within the project area.

Cultural Resources
Under the No Action Plan, continued flooding in the parks and historic neighborhoods would likely result in deterioration of historic resources leading to their degradation and possible loss.

Recreation
Parks and water dependent recreational opportunities within the project would remain the same under the No Action alternative. However, flood events could impact usability of the open space/park adjacent to the Rahway River and Robinson's Branch through inundation or deposition of debris that could result on park closures.

Aesthetics and Scenic Resources
Under the No Action Alternative, aesthetic and scenic resources would remain unchanged from current conditions.

Hazardous, Toxic and Radioactive Waste
The No Action alternative would not change the HTRW conditions within the area.

Air Quality
Ambient air quality would remain unchanged when compared to existing conditions under the No Action alternative. The No Action alternative would not result in any loss of vegetation, including trees, and would not likely result in the reduction of carbon sequestration or energy use. However, older trees that have reached the end of their life span, subject to insect damage or lack of maintenance, may be more susceptible to loss during storm or flood events.

Noise
Under the No Action alternative, noise conditions would remain unchanged when compared to existing conditions.

4.4.3 Economic Without Project Conditions
Because the study and project areas are well developed, there is little opportunity for new expansion. The total depreciated structure replacement value of the existing structure inventory in the project area is estimated to be approximately $1.75 billion, with a total residential (non-apartment) valuation of over $350 million (October 2016).

4.4.4 Estimate of Future Without Project Damages
The Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA) model model links the predictive capability of hydraulic modeleing with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the damages and benefits of alternatives within the project area. HEC-FDA fully incorporates risk and uncertainty, and is used to simulate future flood damages at existing and future years and to compute accumulated present worth damages. HEC-FDA is an event-driven life-cycle model that estimates damages and associated costs over the 50-year period of analysis based on storm probabilities and other factors. Damages or losses include depreciated structure value, content and vehicle damage.

Future Without Project Condition Damages. The HEC-FDA model was used to estimate damages to the assets in the study area over the 50 year period of analysis with no Federal action (i.e. the "future without

project condition" (FWOP)). Detailed information on the damage inventory, damage calculations, and HEC-FDA are provided in Appendix B (Economics).

In total 2,502 structures in the study area were identified to be located within the 500-year coastal storm surge floodplain, though 195 of the structures were constructed after 1990. In accordance with Section 308 of WRDA 1990 (33 USC 2318), structures in the 100-year floodplain that were built after 1990 were selected for exclusion from the benefit pool. After examination of the structures via Google Earth in aerial and street view, it was concluded that the structures are not necessary for conducting a water-dependent activity, and were excluded from further analysis. The remaining 2,307 structures formed the inventory upon which all analyses were conducted.

Table 17 presents a summary of the numbers of structures experiencing damage at selected annual chance exceedance events across the whole study area, broken down by damage category. Note that Table 17 was compiled without the application of risk and uncertainty to water surface elevations or structure elevations in the HEC-FDA model. Table 18 presents a summary of the distribution of building types in the study area and total depreciated structure replacement values at October FY16 price levels by damage categories and municipalities.

Table 17. Summary of Damaged Structures by Flood Event

Damage Category	Annual Chance Exceedance Event						
	50% (2-yr)	20% (5-yr)	10% (10-yr)	4% (25-yr)	2% (50-yr)	1% (100-yr)	< 1% (>100-yr)
Residential	40	88	129	231	395	569	1,205
Apartment	8	10	10	11	12	17	25
Commercial	8	13	20	30	42	55	105
Industrial	2	219	231	248	301	354	463
Utility	4	4	8	16	29	34	46
Municipal	4	4	6	10	15	26	42
Total	**66**	**338**	**404**	**546**	**794**	**1,055**	**1,886**

Table 18. Proportions of Structures by Damage Category

Damage Category		% of Total	Average Value*
Residential	No. of Structures	66%	$ 244,000
	Value	21%	
Apartment	No. of Structures	10%	$ 4,777,000
	Value	6%	
Commercial	No. of Structures	22%	$ 2,766,000
	Value	30%	
Industrial	No. of Structures	13%	$ 1,022,000
	Value	3%	
Utility	No. of Structures	66%	$ 4,714,000
	Value	21%	
Municipal	No. of Structures	10%	$ 1,335,000
	Value	6%	

*Price level October 2016

Using HEC-FDA, Average Annual Damages (AAD) were calculated for the without-project base year (2021) and the future condition, and Equivalent Annual Damages (EAD) were calculated for the 50-year period of analysis, using the 2017 fiscal year USACE project evaluation and federal plan formulation discount rate of 2.875%. Table 19 shows that the total equivalent annual damage resulting in these calculations is approximately $17.5 million for the study area.

Table 19. Summary of Without-Project Equivalent Annual Damages by Category and Damage Reach

Damage Reach	Res	Aptmnts	Autos	Comm	Indus	Util	Mun	TOTAL
Carteret & Woodbridge	1,405,400	100	70,800	382,300	7,106,000	651,800	45,600	9,662,100
Millburn-Clark	327,000	133,800	25,800	233,400	29,400	35,600	0	784,800
Rahway	699,300	272,200	37,400	2,719,400	72,700	1,800	32,400	3,835,200
Robinsons Branch	643,800	66,800	18,700	323,900	0	0	2,400	1,055,500
South Branch	266,700	200	8,400	483,200	1,423,000	0	7,600	2,189,000
TOTALS	3,342,200	473,100	161,100	4,142,200	8,631,100	689,200	88,000	17,526,600

Price level October 2016, 2.875 % discount rate

Inspection of the results shows that the reaches that experience the largest single without-project condition damages are within Carteret and Woodbridge, and within Linden, which is included in the Carteret and Woodbridge reaches. The City of Rahway also experiences significant damages, most notably to commercial structures. It is worth noting, however, that the average structure value of commercial structures in the study area is roughly a dozen times of the value for residential structures.

Sea Level Rise

Alternatives in this study were developed assuming a low rate of sea level rise in order to identify the TSP. The low rate of rise was selected to allow for a conservative estimation of claimed benefits for alternatives. As the TSP is optimized its performance will be evaluated for intermediate and high rates of sea level change. The reader should refer to the Hydraulic Appendix for more information.

Critical Infrastructure

Critical infrastructure consists of emergency services, a nearby hospital, petroleum/chemical facilities and road/rail transportation routes. Critical infrastructure is displayed in Figure 23 in Section 5.0.

4.5 Key Uncertainties

Limitations to the quantity and quality of information result in an uncertainty.

Environmental Assessment: An Environmental Assessment will be prepared. As a result of optimization additional public reviews may be required. Later analysis and public coordination may determine if additional public reviews are required. At this time no issues have been identified that would warrant additional public reviews. The PDT has chosen to tolerate the risk and assume preparation of an Environmental Assessment.

4.6 Management Measures – Screening of Candidate Measures

For the initial iteration of the planning process potential measures were formulated and screened. In general, measures are types of actions that accomplish the study objectives when implemented. Strategies to address fluvial flood risk include structural measures, nonstructural measures, and no action. To enact these strategies, nonstructural measures (actions to reduce flood damages without significantly altering the nature or extent of flooding) and structural measures (physical modifications designed to reduce the frequency and severity of damaging levels of flood inundation) were examined. These measures can be used individually or combined with other management measures to form alternative plans. The list of measures considered was derived from a variety of sources, including experience from prior studies and coordination with the non-Federal sponsor and local stakeholders.

No-Action

This plan involves no further Federal action to provide coastal storm risk management in the Rahway River Basin. No action would be implemented if project costs exceed project benefits, thus indicating that storm risk management measures are not in the Federal interest under current National Economic Development (NED) guidelines. The no action plan fails to meet any of the study objective of managing coastal storm surge flooding risk in the portions of the Rahway River Basin subject to flooding from coastal storm surge and represents the default condition if no other plan is recommended for further action. This plan serves as the baseline against which the benefits and costs of other alternatives are compared.

Nonstructural Measures

Non-structural flood risk management measures are techniques for reducing accountable flood damages within floodplains. These techniques consist of measures such as relocation, acquisition, flood proofing (wet/dry), raising/elevations, flood warning systems, flood emergency preparedness plans, and public education. Some of the measures (i.e., flood proofing and raising) maintain residential, commercial, and industrial areas, reducing flood damages through modifications of the existing structures. Other treatments include such measures as buying and removing low-lying high risk properties from the floodplain. For areas or structures where non-structural measures are not appropriate, structural measures such as ringlevees and ringwalls are considered. These structural treatments have the potential to affect the floodplain and require further hydraulic analysis.

The non-structural measures to be considered in this feasibility study include dry flood proofing (e.g., sealing basement windows on residential properties), wet flood proofing, elevation (raising buildings) and pump replacements. Relocations and acquisitions (buyouts) were not considered in this analysis. Buyouts are considered where the cost of the treatment exceeds the cost of the buyout. This evaluation occurs in the later design stages.

- *Dry Flood Proofing*. Flood proofing is the process of making adjustments in the design or construction of buildings to reduce potential flood damages. Dry flood proofing measures allow flood waters to reach the structure but diminish the flood threat by preventing the water from getting inside the structure. Dry flood proofing measures considered in this screening make the portion of a building that is below the flood level watertight through attaching watertight membranes and installing closure structures in doorway and window openings, referred to as sealants and closures.
- *Wet Flood Proofing*. Wet flood proofing measures allow flood water to get inside lower, non-living space areas of the structure via vents and openings in order to reduce the effects of hydrostatic pressure and, in turn, reduce flood-related damages to the structure's foundation. When a basement is involved, it is filled with compacted earth for foundational stability. Wet flood proofing also involves elevating and/or protecting utilities.
- *Elevation (Raising)*. Elevation involves raising the lowest finished floor of a building to a height that is above the flood level. In most cases, the structure is lifted in place and the foundation walls are extended up to the new level of the lowest floor. When a building is in poor condition, elevation is not feasible; in these cases demolition and rebuilding is recommended with the lowest finished floor above the flood levels. The elevation process differs for different foundation types: slab-on-grade, subgrade basement, walkout basement, raised (crawlspace) foundation, bi-levels/raised ranches, or split levels. In this study, no structures were assumed to be elevated on piers, posts, or piles. Elevation was assumed to be feasible for structures having footprint of less than 3,000 sf.
- *Property Buy-Outs.* Buy-outs involve the acquisition of property and its structures and/or the purchase of development rights. A buy-out plan would result in the permanent evacuation of the floodplain in areas of frequent and severe inundation. Development in the areas would cease and structures would be demolished or relocated. A buy-out plan would be successful in re-establishing and maintaining a natural state of the floodplain for purposes that would not be jeopardized by the flood hazard. However, this type of program causes emotional hardship, involves expensive relocation costs, and results in the loss of a community/local tax base.

Structural Measures

Structural features reduce flood risk by modifying the characteristics of the flood. They are often employed to reduce peak flows (flood storage); direct floodwaters away from flood prone property (flood barriers); or facilitate the flow of water through or around an area (channel modifications or diversions). All of these features have the potential to reduce flood damages; however, not all may be economically justified. Structural measures

considered in the formulation of alternative plans include diversion culverts, levees/floodwalls, channel modifications, detention basins and clearing and snagging. These structural measures and the results of the initial screening are described below.

- *Floodwalls.* Floodwalls are structures composed of steel, concrete, rock, or aluminum that are used to manage flooding risk by helping to contain flows to a channel and away from areas prone to flood damage. They are often used when residential properties directly abut a channel or the shoreline and there is not enough space to construct a levee, or in cases where storm induced floods are too severe for a levee. Interior drainage facilities, located on the landward side of the floodwall, are considered in order to collect, control, and disperse water trapped behind the floodwall as floodwaters could otherwise pond behind the floodwall, creating the potential for induced flooding.
- *Levees.* Levees are typically low, wide earthen embankments built to retain floodwater inside a channel and away from areas prone to flood damage. Interior drainage facilities, located on the landward side of the levee, are considered in order to collect, control, and disperse water trapped behind the levee as floodwaters could otherwise pond behind the levee, creating the potential for induced flooding. Additionally, floodwaters ponded behind the barrier could potentially breach the levee.
- *Surge Barriers.* Surge barriers are used to alleviate the inundation of landward areas as floodwaters enter canals and creeks. During flood events, surge barriers placed across waterways would be closed. Levees and floodwalls are often used in conjunction with surge barriers to tie-off to appropriate points of elevation to prevent floodwaters from flanking the surge barrier.
- *Road Raising*. Roads that currently experience flooding during storms due to coastal storm surge waters or surface runoff would be elevated to heights that would minimize or eliminate the impacts of such events. While road raisings are not usually recommended as a sole project element they are sometimes used in conjunction with levees and floodwalls where roads intersect levees and floodwalls to maintain
- *Channel Modification.* Modification of the cross-section of a channel of water along a length or lengths of that channel can sometimes improve flow and reduce or prevent fluvial flooding.
- *Barriers (aka. Ringwall or Ringlevees)*. Barriers usually surround the building(s) and are sometines used where nonstructural measures are not feasible. These could be either ring floodwalls or ring levees, depending on such factors as available space and cost. It is often used where the elevation of a structure is not feasible, as in the case of a large commercial structure.

4.7 Initial Alternatives Array – Evaluation of Measures

The flood risk management measures described above were screened based on the degree to which they met the project objectives and minimized or avoided project constraints. Specifically, measures were evaluated based on their ability to reduce storm induced damages to the project areas. The screening of measures is documented in Table 20.

Those measures that are not entirely screened out are carried forward for more detailed analysis as alternative plan components.

Table 20. Evaluation of Initial Alternatives

Measure	Outcome	Challenges	Retained for Further Study?
No Action	• Existing economic, social, and environmental conditions and trends within the affected area continue with no recommended Corps project.	• Continued potential for loss of life and physical, as well as environmental, damage to study area communities in the occurrence of significant flooding. • Significant flooding can result in municipal infrastructure damage, loss of jobs, and closure of businesses.	• Yes, per NEPA and ER 1105-2-100, the No Action Plan is the basis for comparison.
Tidal/Closure Gate	• Help reduce damages throughout the basin by protecting areas traditionally sustaining flood damages from coastal storm surge/overbank flooding.	• Impacts to navigation must be fully assessed. • Construction costs could be significant.	• Yes, while costs may be high, this measure will meet the planning objectives to reduce flood impacts in the basin.

Levee / Floodwall	• Help reduce flood damages throughout the basin by protecting areas traditionally sustaining flood damages from coastal storm surge/overbank flooding.	• Destruction of wetlands and impacts to jurisdictional waters. Full environmental assessment and impact analysis is required. This could result in high environmental mitigation costs. • Costs for acquisition of real estate interests may be high. • Additional exploration for potential cultural and historic resources needs to be completed. Significant cultural resource mitigation may be required.	• Yes, while costs may be high, this measure will meet the planning objectives to reduce flood impacts in the basin.
Measure	**Outcome**	**Challenges**	**Retained for Further Study?**
Beachfill or breakwater in the Arthur Kill area	• Help reduce flood damages throughout the basin by protecting areas traditionally sustaining flood damages from coastal storm surge/overbank flooding.	• Shoreline and area directly inland of the Arthur Kill are highly industrialized and no room exists for such measures. The Arthur Kill also contains a navigation channel for large ships that would preclude breakwaters in the Arthur Kill itself.	• Not considered for further study as the shoreline and area directly inland of the Arthur Kill are highly industrialized and no room exists for such measures and the Arthur Kill is a major navigation channel.
Floodproofing of flood prone residences, businesses and public facilities subject to frequent flooding	• Reduce coastal storm surge flood damages to properties. • Minimize environmental impacts.	• Floodproofing a significant portion of floodplain properties would be prohibitively expensive. • Public acceptability of a large-scale plan is sometimes challenging.	• Retained for further study as this measure will meet the planning objectives to reduce flood impacts in the basin. As per ER 1105-2-100, a non-structural flood risk management plan must be examined to compare against

			structural flood risk management plans.
Permanent evacuation of residences and businesses (buyouts)	• Reduce coastal storm surge flood damages to properties. • Minimize environmental impacts and possibly create additional open space and floodplain area.	• Acquisition and relocation of a significant portion of floodplain properties would be prohibitively expensive. • Public acceptability of a large-scale plan is sometimes challenging.	• Retained for further study as this measure will meet the planning objectives to reduce flood impacts in the basin. As per ER 1105-2-100, a non-structural flood risk management plan must be examined to compare against structural flood risk management plans.

4.7.1 Refined Measures

The primary objective of this study is to manage the risk of flooding caused by coastal storm surge in the project area. Formulated measures are focused on reducing coastal storm surge flood risk along the Rahway River and its tributaries, Robinson's Branch and South Branch, in the areas of the municipalities of Carteret, Linden, Rahway and Woodbridge. Refined measures that survived initial screening include no action (same as future without project conditions), structural, and nonstructural alternatives. The structural measures include levees, floodwalls, surge barriers, ringwalls, and/or a combination of the above. Non-structural measures include dry flood proofing, wet flood proofing, elevating/raising structures, and buyouts. Other alternatives were preliminarily evaluated and omitted due to inability to meet the study objectives. Low levels of performance, high cost, and/or potentially high environmental impacts are potential contributors to measures being screened out of further consideration.

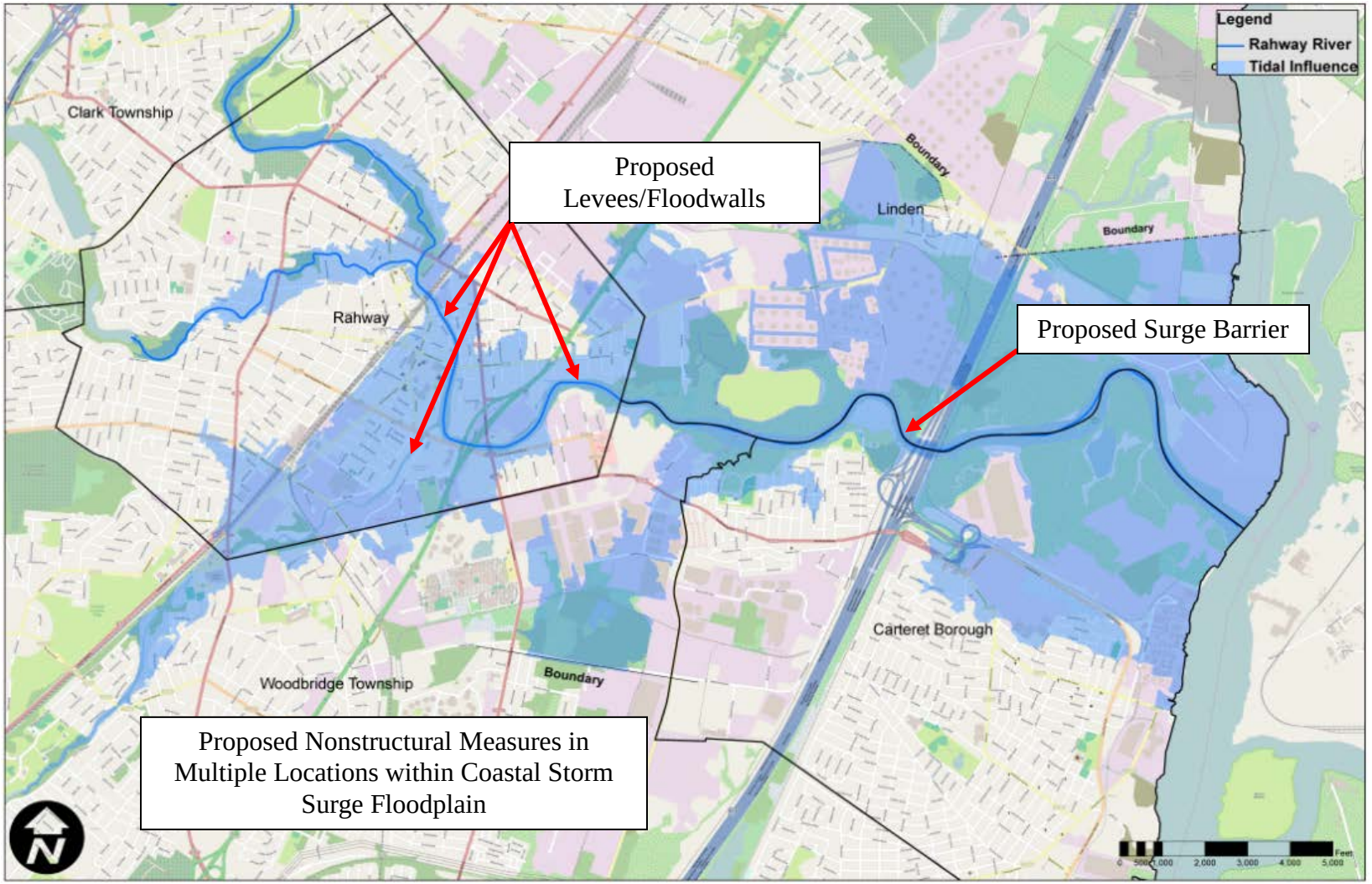


Figure 11. Refined Measures

4.8 Final Array of Alternative Plans

An alternative plan is a set of one or more management measures functioning together to address one or more planning objectives. Those measures that were not screened out for further consideration were developed into the final array of numbered alternative plans.

Based on the measures carried forward, both structural and non-structural alternative plans were developed for more detailed analysis. Structural plans under consideration include: levees/floodwalls and a surge barrier/closure gate in conjunction with levees/floodwalls. Pumping stations may be necessary behind the levee/floodwalls to control interior drainage. In addition to structural alternative plans, the no-action (without project) and non-structural alternative plans were also evaluated.

The following alternative plans have been carried forward for further analysis.

- No Action (Without Project)
- Alternative #1: Levees and Floodwalls
- Alternative #2: Surge Barrier
- Alternative #3a & 3b: Nonstructural Measures + Barriers
- Alternative #4 & 4a: Levee Segment D + Nonstructural Measures

Note that with respect to Alternative #2: Surge Barrier, two alignments were developed to provide a surge barrier via a surge barrier/closure gate with tie-in levees/floodwalls.

The first alignment includes a surge barrier/closure gate at the mouth of the Rahway River by the Arthur Kill. A levee on the Arthur Kill and north of the left bank of the Rahway River in the City of Linden and a levee on the Arthur Kill and south of the right bank of the Rahway River in the Borough of Carteret would be included to tie-off to high ground. This alignment could provide storm risk management to various residential, commercial and industrial structures within all four municipalities in the study area, including the petroleum refineries. However this alignment was screened out of further consideration for three collective reasons: 1) Following Hurricane Sandy in 2012 some of the petroleum facilities implemented storm risk measures to manage coastal storm surge flooding risk, thus reducing the damage pool; 2) Technical difficulty in placing tie-in floodwalls along the Arthur Kill on top of industrial petroleum/chemical facilities and anticipated high real estate mitigation costs; and 3) HTRW issues in the direct vicinity of contaminated sites that would require remediation prior to implementation of a USACE project (further complicated by the immediately adjacent location of the Arthur Kill channel and the ongoing chemical/petroleum operations in the direct vicinity).

The second alignment is a surge barrier/closure gate to the west/upstream of the NJ Turnpike on the Rahway River. This alignment could provide storm risk management to various residential, commercial and industrial structures within all four municipalities in the study area, but would not manage storm risk for the petroleum refineries east/downstream of the NJ Turnpike on the Rahway River. This alignment is the plan presented in Alternative #2: Surge Barrier.

No Action Plan: This plan involves no further Federal action to provide coastal storm risk management in the Rahway River Basin. No action would be implemented if project costs exceed

project benefits, thus indicating that storm risk management measures are not in the Federal interest under current National Economic Development (NED) guidelines. The no action plan fails to meet any of the study objective of managing flooding risk in the portions of the Rahway River Basin subject to coastal storm surge and represents the default condition if no other plan is recommended for further action. This plan serves as the baseline against which the benefits and costs of other alternatives are compared.

The no action alternative provides some indication as to what future conditions would be in the absence of the project. The No Action alternative avoids environmental and other impacts associated with implementation of other plans for flood risk management. The population, industries, and businesses are either stable or growing, indicating land-use and rainfall runoff increase. Climate and sea level change analyses indicate an increase of 0.81 ft WSEs. As future trends indicate higher flows and sea level rise, the result of no further Federal action would be the continuation and future increase of flooding problems in the study area.

Alternative #1: Levees and Floodwalls
This structural alternative consists of a combination of four (4) levee/floodwall segments, two (2) closure gates, interior drainage structures, and channel modification. The improvements are located in Clark, Carteret, and Linden Townships. This alternative, at present conditions, is likely to have a 1% chance of annual exceedance in the protected areas. See Figure 12 for the overview of the alternative and Figures 13 and 14 for the plan layout of each component.

The segments are described as follows:

(1) Segment A: Levees and floodwalls, channel modification, bridge replacement, and road closure gate.
The upstream section, Segment A1, starts with "T-wall" floodwalls in both banks of the Rahway River near Bridge St. The left bank floodwall is approximately 325 ft long while the right bank floodwall is approximately 210 ft long, each at elevation 13.8 ft NAVD'88. This section of floodwalls in both banks of the river ends at Monroe Street Bridge. The bridge shall be raised by 2.8 ft, and the left abutment shall be moved inland by 15 ft. As result of bridge modification, approximately 300 ft of Monroe St. shall be raised by a maximum of 2.8 ft. The raised section of road ties in into the existing roadway surface at the intersection of Monroe St. and Essex St.

The left bank floodwall continues downstream towards Essex St. with a top elevation of 12.6 ft. NAVD '88. The floodwall tie-in to Essex St. requires the road to be raised by approximately 1.5 ft. The raised section is approximately 150 ft. long and starts 50 ft. south the intersection of Essex St. and Washington St.

Segment A2 starts on the left bank of the Rahway River, approximately 150 ft. north of E. Milton Avenue Bridge. This section is a sheet pile wall with a maximum height of approximately 2 ft. Sheet pile ties into high ground at the recently modified bridge. A levee section starts downstream of E. Milton Avenue Bridge and ties into high ground on the abutments of the Edgar Rd. exit (Route 1). The levee is approximately 1,510 ft. long, with an average height of 4 ft., having a 12 ft. top width and one vertical to three horizontal (1:3) side slopes.

The final section of Segment A2 is a floodwall approximately 580 ft. long with an average height of 5.5 ft., located between the Route 1 exit and Route 1 itself. This section will also include a flood hydrostatic gate (road closure structure) approximately 65 ft. wide by 6 ft. high. The gate is located on Lawrence St. approximately 300 ft. south of the Hancock St. and Lawrence St. intersection.

Channel modification is necessary in order to mitigate for the impact (induced flooding) of bank encroachments caused by existing levees in the Rahway River and the additional features of Segment A. The upstream and downstream ends of channel modification are: 500 ft. upstream of W. Grand Avenue Bridge upstream of the confluence with Robinson's Branch and approximately 100 ft. downstream of Lawrence Street Bridge downstream of the confluence with the South Branch, respectively. The channel modification consists of a natural trapezoidal channel with one vertical to two and a half horizontal (1:2.5) side slopes. It is approximately 6,540 ft. long, totaling 60,000 cy of dredged material. The channel modification slope and bottom width are variable. The slope upstream of the NJ Transit Railroad Bridge is approximately 9.5 ft./mile and downstream is approximately 1.6 ft./mile, having bottom widths ranging from 35 ft. to 140 ft. This channel modification mostly removes high ground sections along the channel caused by high deposits of sediment. The channel modification will not only reduce upstream impacts but will also reduce flood risk during frequent fluvial events.

(2) Segment B: Levees, floodwalls and road closure gate.
This segment is a combination of levee and floodwall. The levee has a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. It is approximately 640 ft. long with an average height of approximately 8 ft from grade. This levee is located on the right side of Edgar Rd. just north of Randolph Ave.

The floodwall is a sheet pile approximately 5,700 ft. long with an average height of approximately 3.8 ft. The floodwall is located on the right bank of the South Branch, between the riverine and Leesville Ave. The upstream end of the floodwall is approximately 1,300 ft. downstream of E Inman Ave. and the downstream ends is approximately 600 ft. upstream of E Hazelwood Ave. Segment B also includes a flood hydrostatic gate (road closure structure). The dimension of the road closure structure is 40 ft. wide by 5 ft. high and it is located in the north end of Capobianco Plaza Rd.

(3) Segment C: Levee.
This levee segment is 890 ft. long with a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft from grade. The levee is located on the left bank of the Rahway River, approximately one mile downstream of the confluence with the South Branch. The upstream end is located by Beacon St., continues downstream, and ties in into high ground approximately 150 ft. downstream of Wall St.

(4) *Segment D: Levee.*
This levee segment is 3,360 ft. long with a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft from grade. The levee is located next to the right bank of the Rahway River, approximately 1.2 mile downstream of the confluence with the South Branch. The upstream end is located at the industrial/commercial area by Ardemore Ave., continuing downstream to Dorothy St.

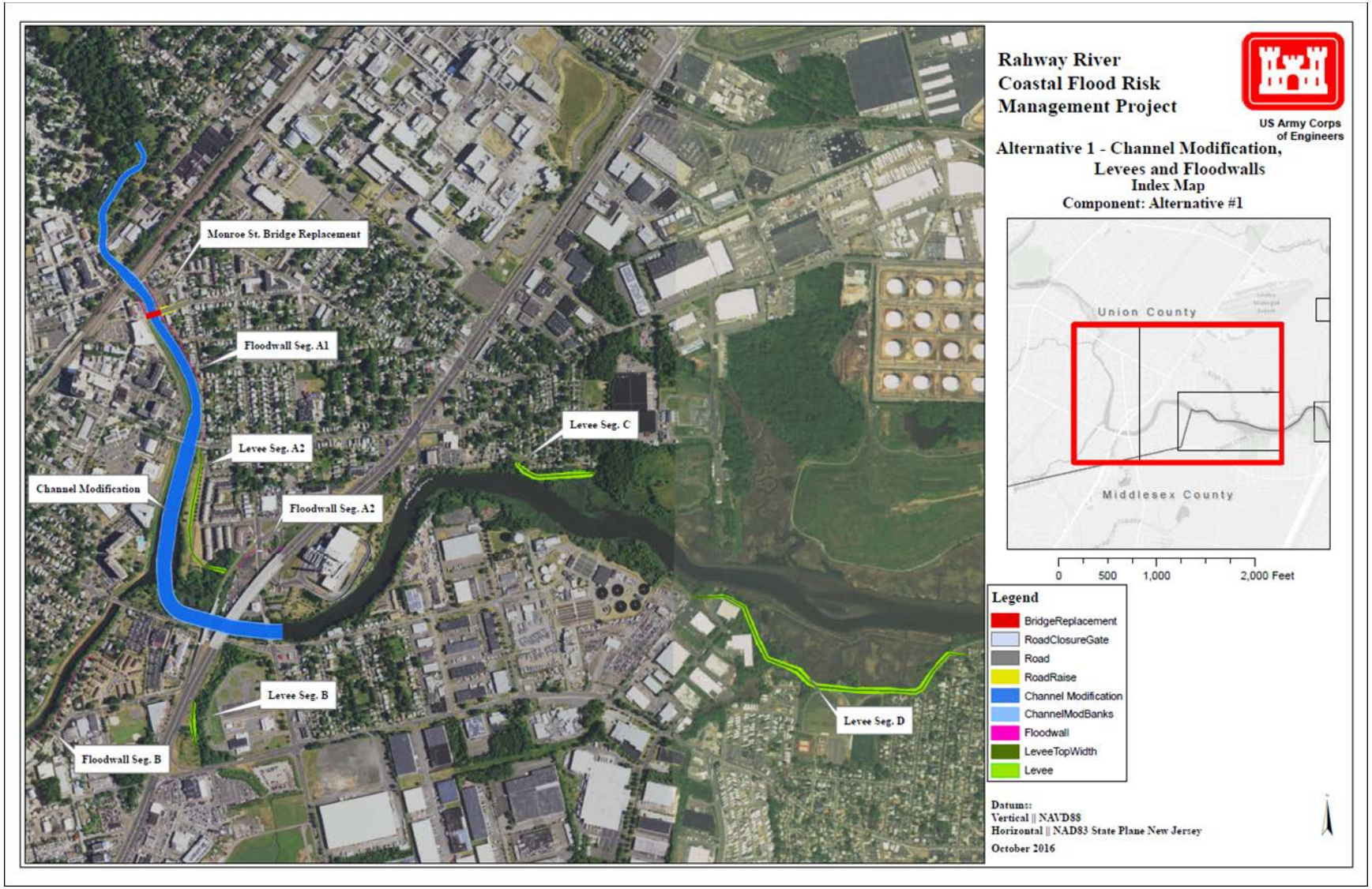


Figure 12. Alternative #1 Plan Overview

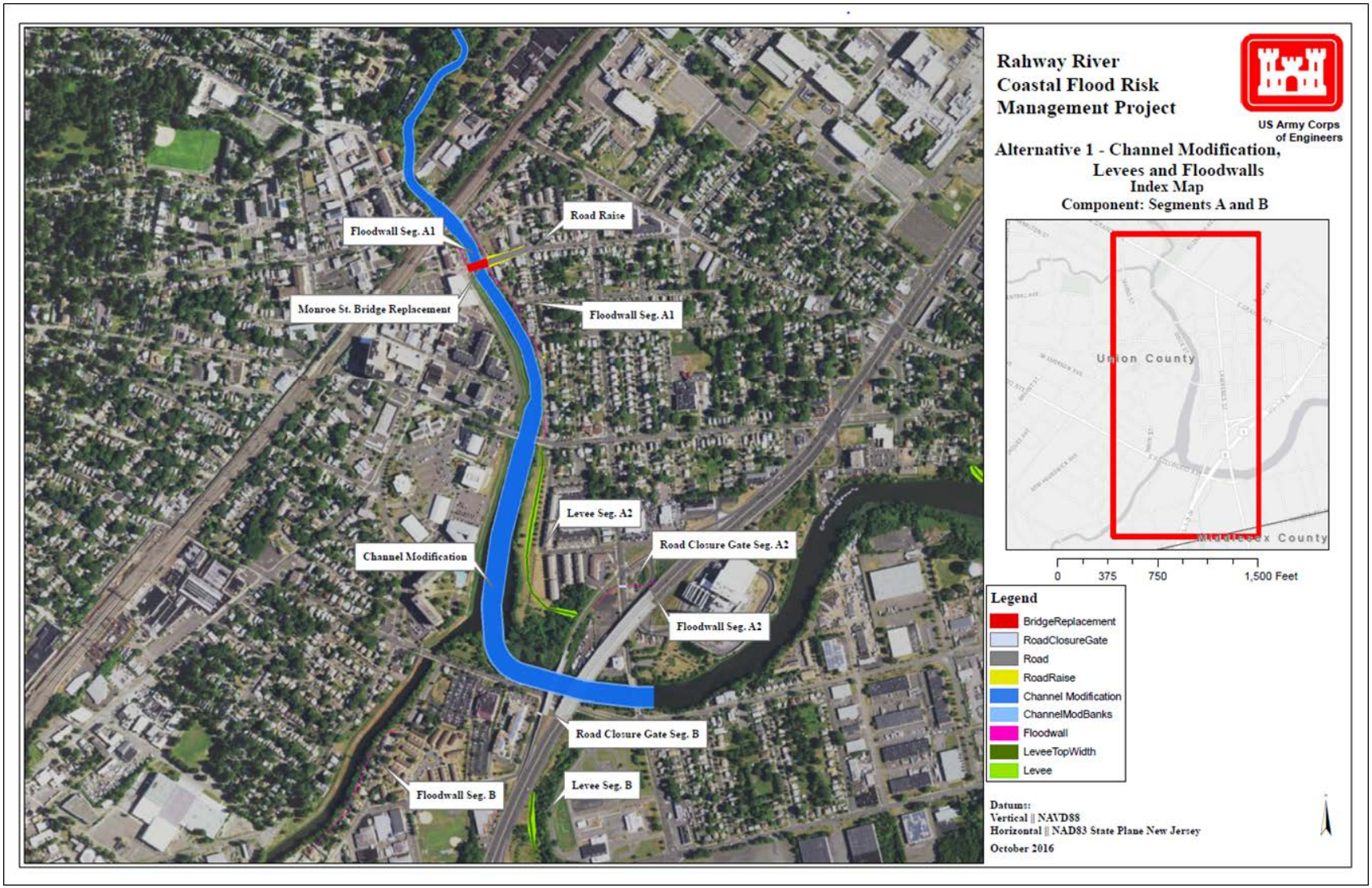


Figure 13. Alternative #1 – Levee Segments A and B

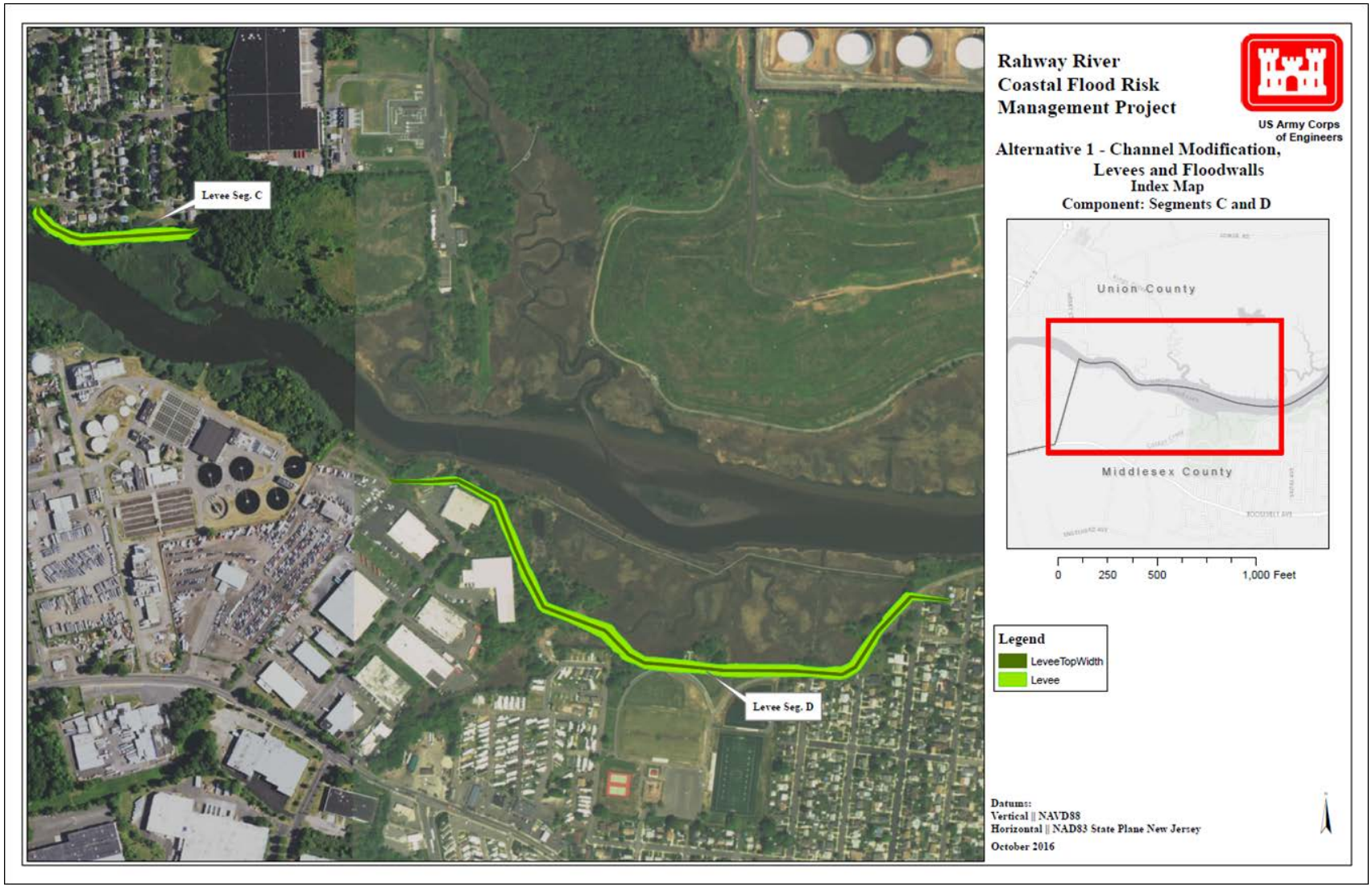


Figure 14. Alternative #1 – Levee Segments C and D

Alternative #1 – Hydraulic Analysis
The design height of hydraulic features will be at elevation 12.6 ft. NAVD ’88, consistent with the existing levees in the City of Rahway. Levees, floodwalls, and road closure structures were designed to this height and evaluated based on their performance during the 1% ACE hypothetical event in HEC-RAS. The bank encroachment caused by existing levees in the Rahway and the proposed levees in Segment A induced flooding upstream during model simulation, especially during significant fluvial events. Channel modification was necessary to reduce WSEs to “without project” condition levels. This channel modification will not only reduce upstream impacts but will also reduce flood risk during frequent fluvial events, providing additional benefits to City of Rahway and Clark Township.

Alternative #2: Surge Barrier
This structural alternative’s main feature is a surge barrier consisting of tide gates and a pumping station at the New Jersey Turnpike Bridge. A surge barrier is a specific type of floodgate designed to prevent a storm surge from flooding the area behind the barrier up to a specified design height. The barrier would be upstream of the bridge, i.e. to the west of the Turnpike, spanning across the width of the river from Carteret to Linden. Additional channel modification, levees and floodwalls in both Carteret and Linden, and closure structures complete the plan. This alternative is likely to have a 1% chance of annual exceedance. See Figure 15 for the overview of the alternative and Figures 16-18 for the plan layouts of each component.

The surge barrier is located approximately 775 ft upstream of the New Jersey Turnpike with a design elevation of 13 feet NAVD ‘88. It includes:

(1) Six tainter gates allowing navigable passage,
(2) A pumping station with four pumps at a total capacity of 2.7 million gpm,
(3) Levee tie-ins to high ground (the turnpike) on the left and right banks, and
(4) Channel modification at the surge barrier for a length of approximately 2,000 ft.

The surge barrier contains six tainter gates, each 60 ft wide and 30 ft tall from invert to top of gate. Gates will be open during normal tide conditions and fluvial events. During coastal storm surge events, the gates will close during a rising tide as long as the headwater (landside) has a lower WSE than the tailwater (ocean-side). The pump station is located on the left bank and will tie into the line of protection of the gate components. It contains four 1,500 cfs pumps with a total capacity of 6,000 cfs, or 2.7 million gpm. Pump operation is necessary when the gates are operating so that damage is not incurred to structures upstream of the barrier.

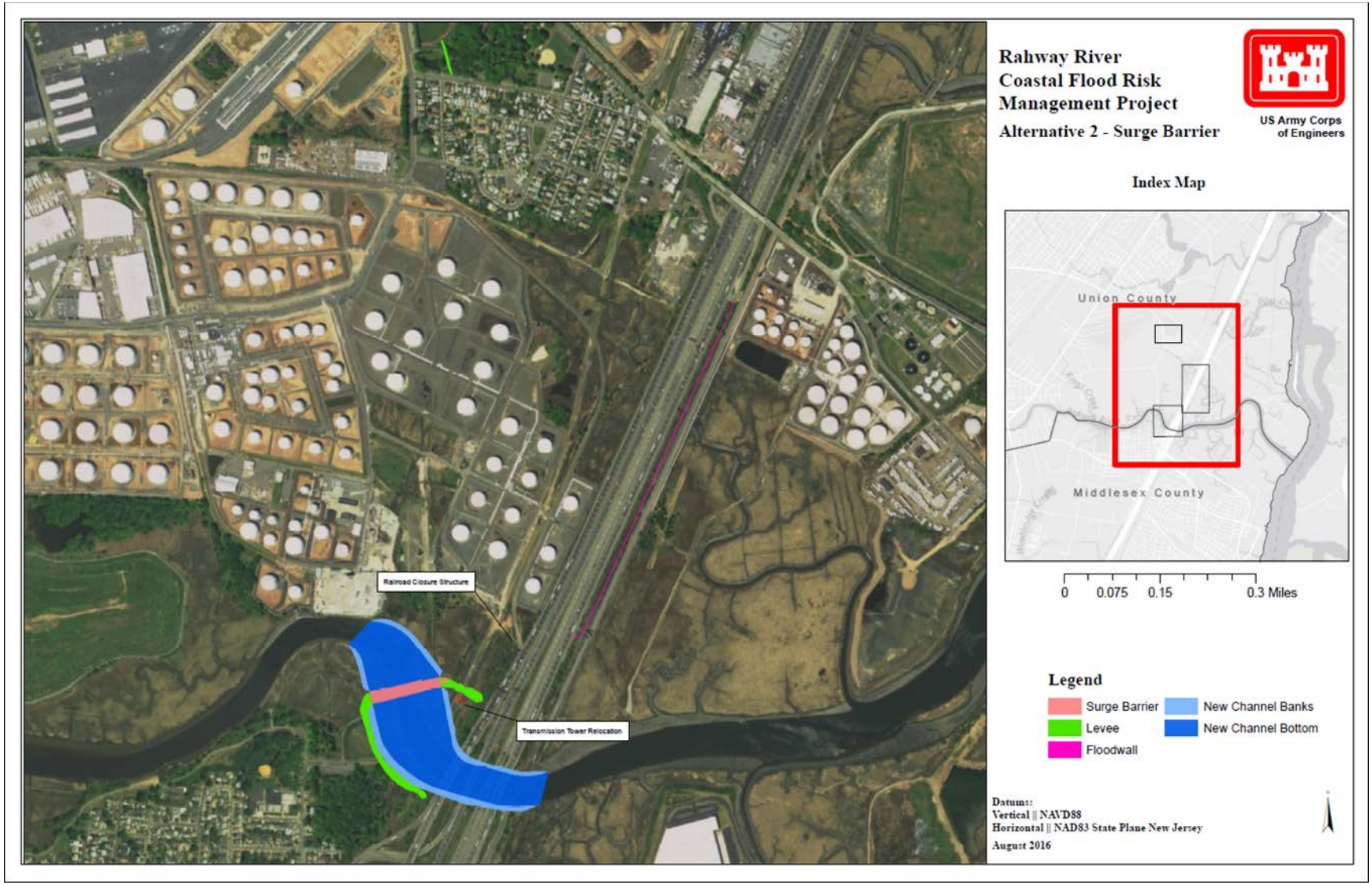


Figure 15. Alternative #2 Plan Overview

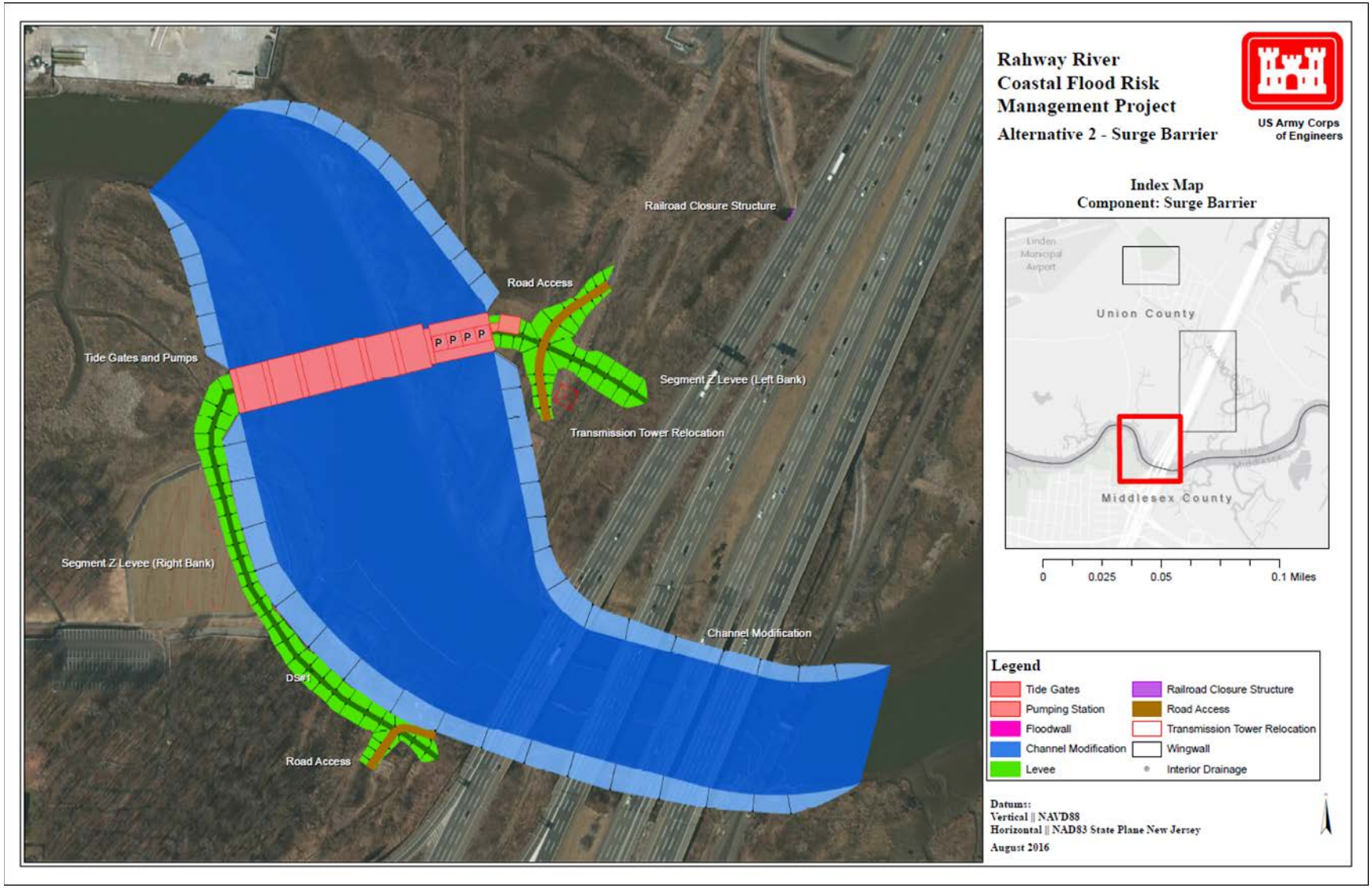


Figure 16. Alternative #2 – Surge Barrier

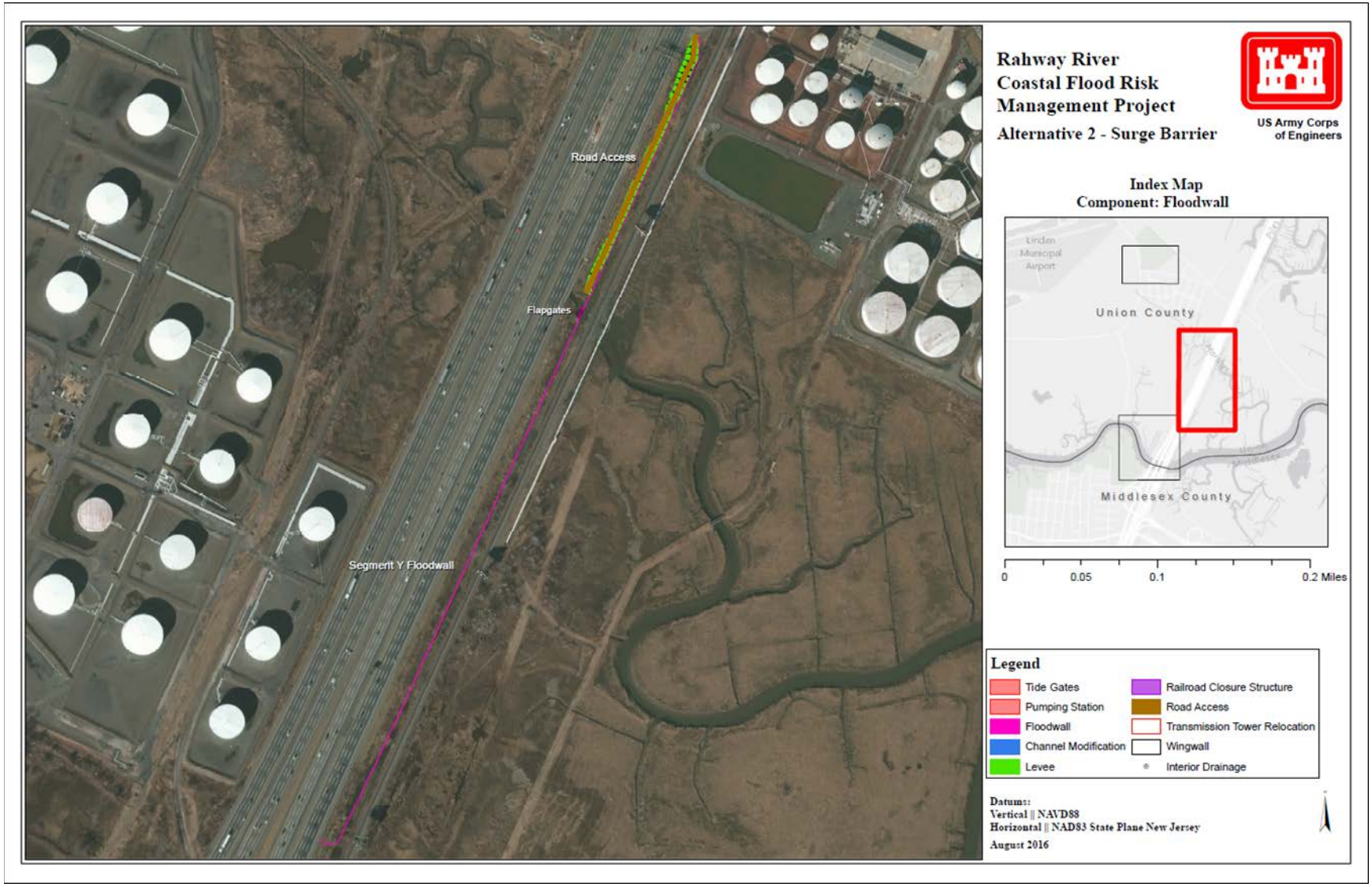


Figure 17. Alternative #2 – Floodwall along New Jersey Turnpike (Northbound Side)

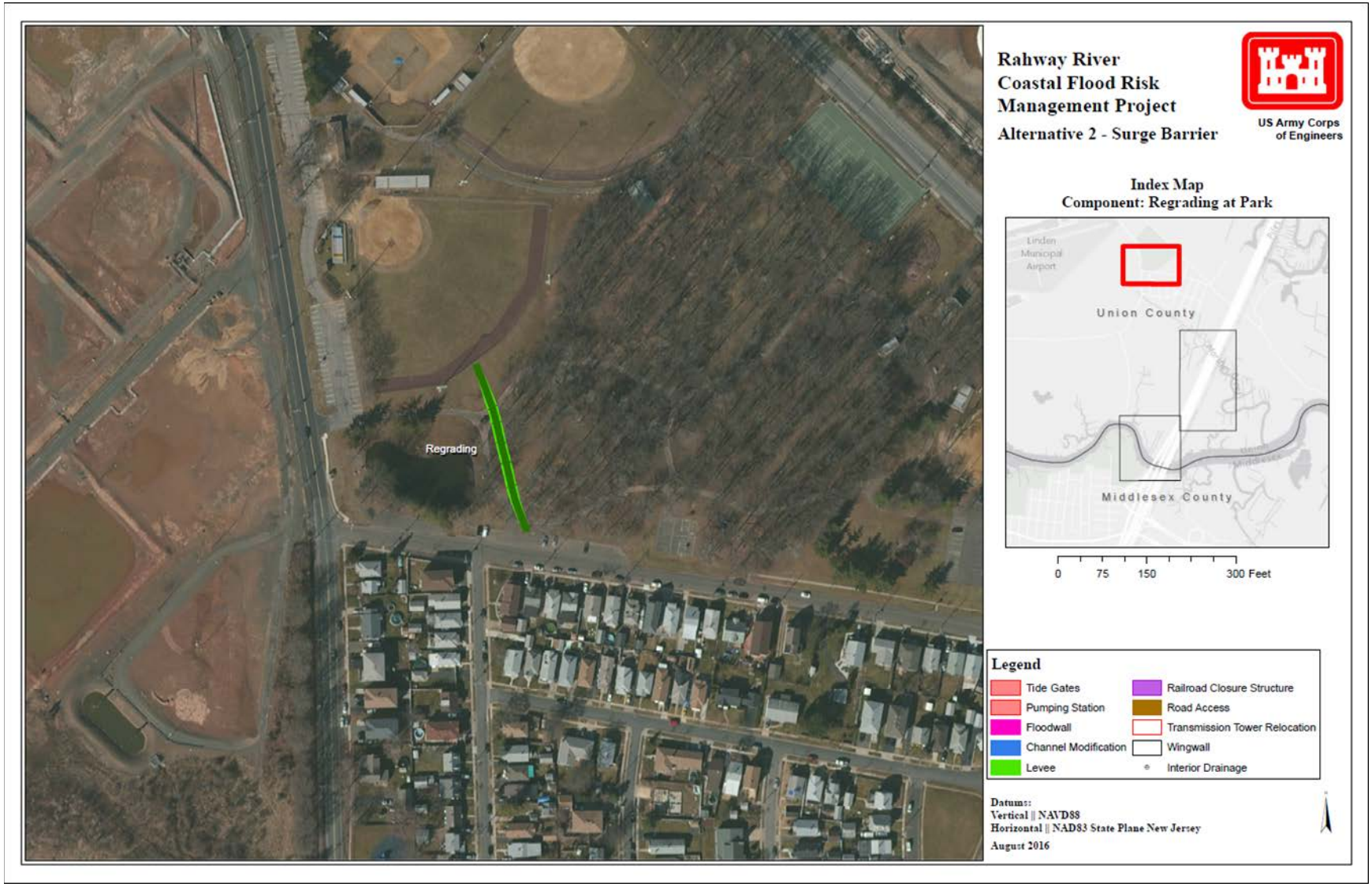


Figure 18. Alternative #2 – Regrading at Memorial Field Park

Alternative #2 - Hydraulic Analysis

Levees on the left and right banks of the surge barrier will tie into the NJ Turnpike. Levees will have a top width of 12 ft and a 1 vertical to 3 horizontal (1:3) side slope. Levee length on the left bank is approximately 380 ft with a design height of 13 ft NAVD ’88, having a maximum exposed levee height of 11 ft. Levee length on the right bank is approximately 1,040 ft with a design height of 13 ft NAVD ’88, having a maximum exposed levee height of 11 ft. The right bank levee includes an 18 inch diameter interior drainage structure.

The surge barrier involves approximately 2,000 ft of channel modifications, totaling 322,000 cubic yards of dredged material. Modification begins approximately 500 ft upstream of the barrier to just downstream of the railroad bridge. Channel modification includes a new alignment of the left bank at the pump station, rectangular cuts immediately upstream and downstream of the barrier, trapezoidal cuts along the length of the channel with a 1:3 side slope, and 1:5 side slopes under the Turnpike and railroad bridges. The channel bed slope will be constant at a natural slope of 0.0013 ft/ft.

The remainder of the project will include:

(1) A floodwall along New Jersey Turnpike Northbound,
(2) Regrading approximately 300 linear ft of Memorial Field Park in Linden, NJ to an elevation of 13 ft NAVD ‘88,
(3) Three manual flapgates in the floodwall on the Northbound side of the Turnpike at Marshes Creek,
(4) A 6 ft high swing gate railroad closure structure on the Southbound side of the Turnpike by the Citgo oil tank farm, and
(5) Relocating the transmission tower on the left bank approximately 130 ft toward the left bank levee, away from the river.

The floodwall component of the alternative is located along the northbound side of the Turnpike between the highway and the railroad running parallel. Length of the floodwall is approximately 3,090 ft with design height 13 ft NAVD ’88 and having a maximum exposed height of 13 ft. The floodwall includes three 8 ft diameter manually operated flapgates at the Marshes Creek outlet. The flapgates will be open during normal conditions as to not affect the tidal environment.

Regrading at Memorial Field Park is minor but necessary to distinguish the Rahway River basin from the Arthur Kill-Upper Bay basin, including Elizabeth River and Morses Creek. The one foot regrading will prevent elevated water levels in the nearby basin from causing flooding in the study area.

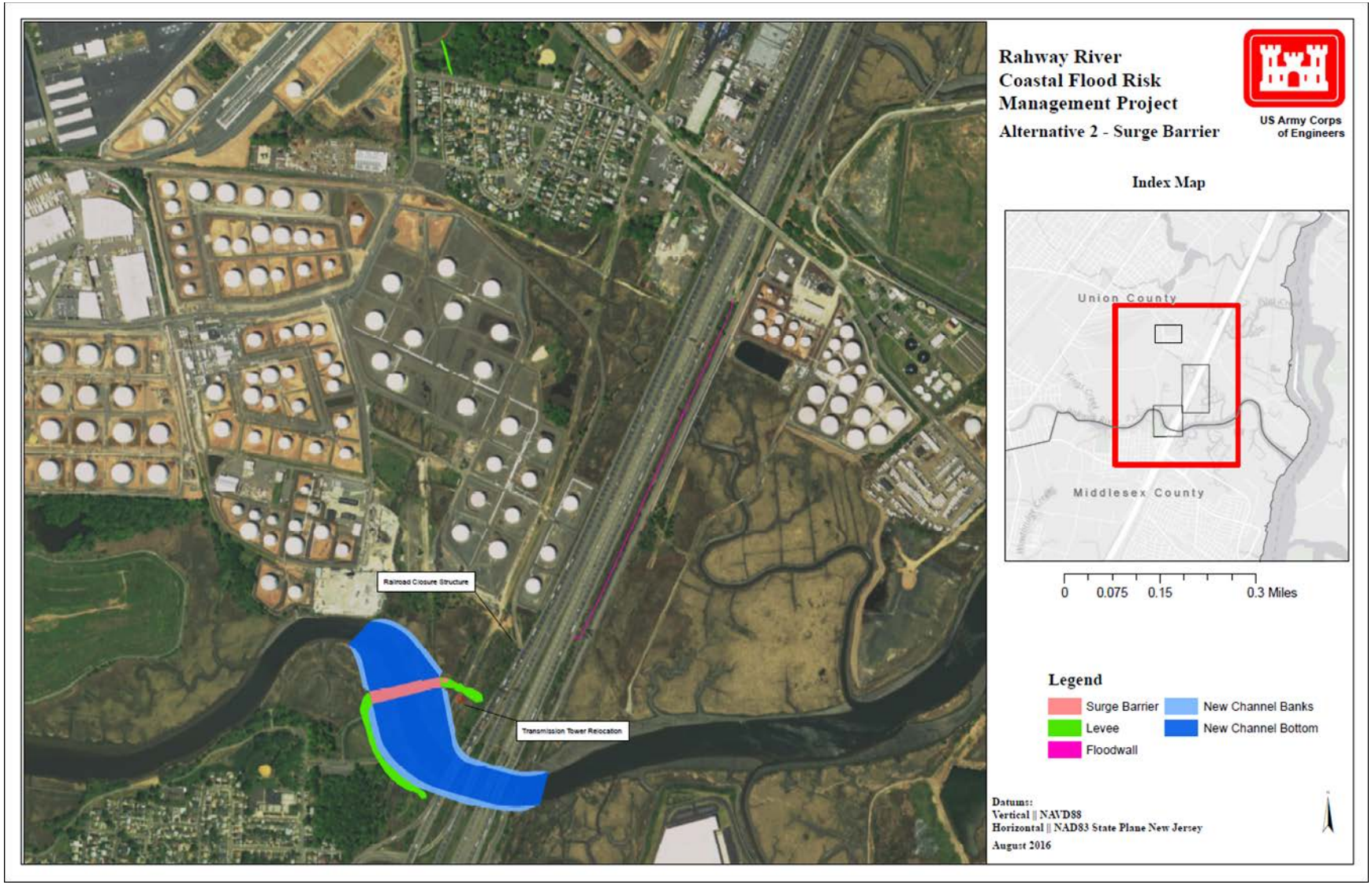


Figure 15. Alternative #2 Plan Overview

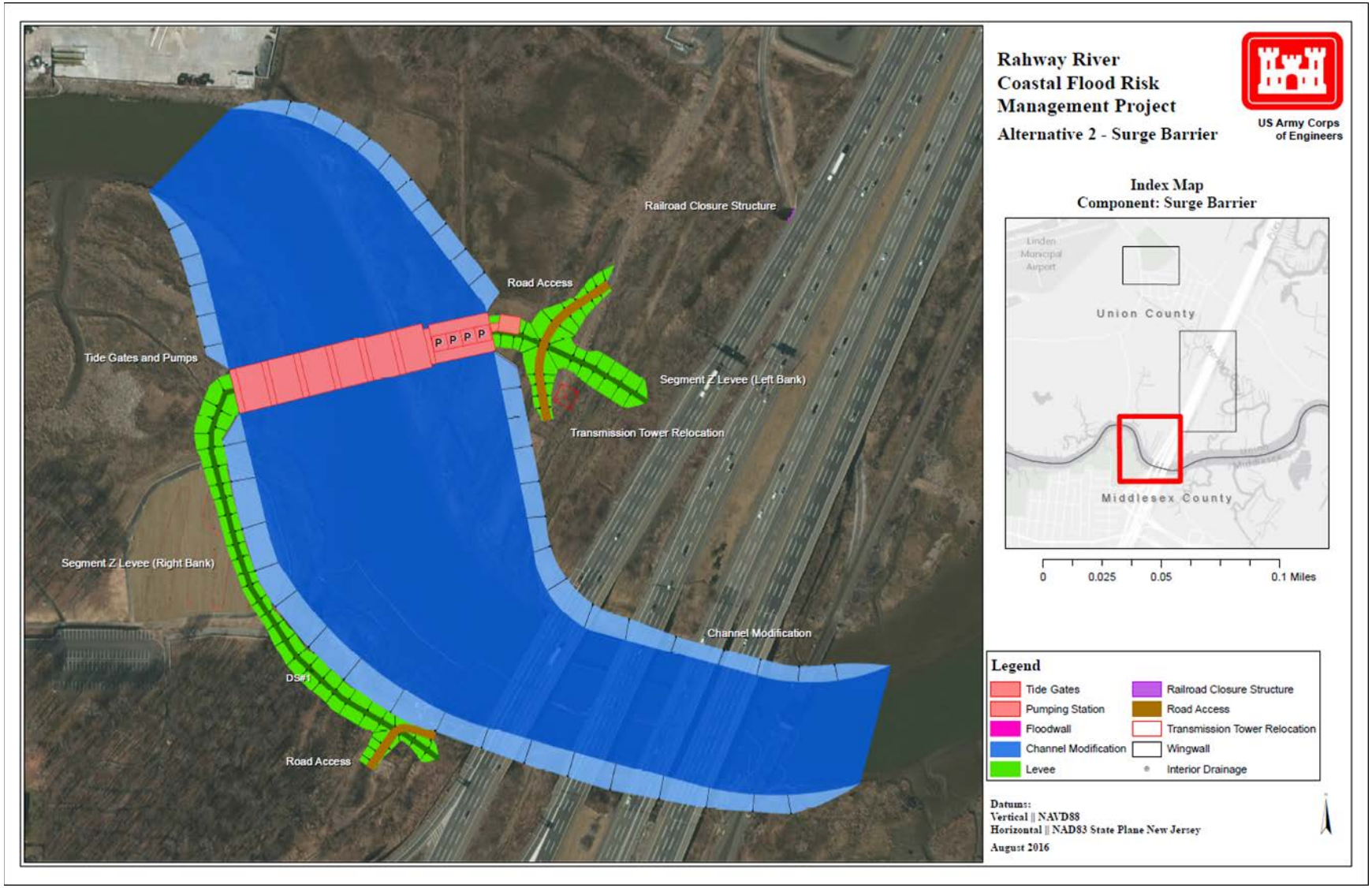


Figure 16. Alternative #2 – Surge Barrier

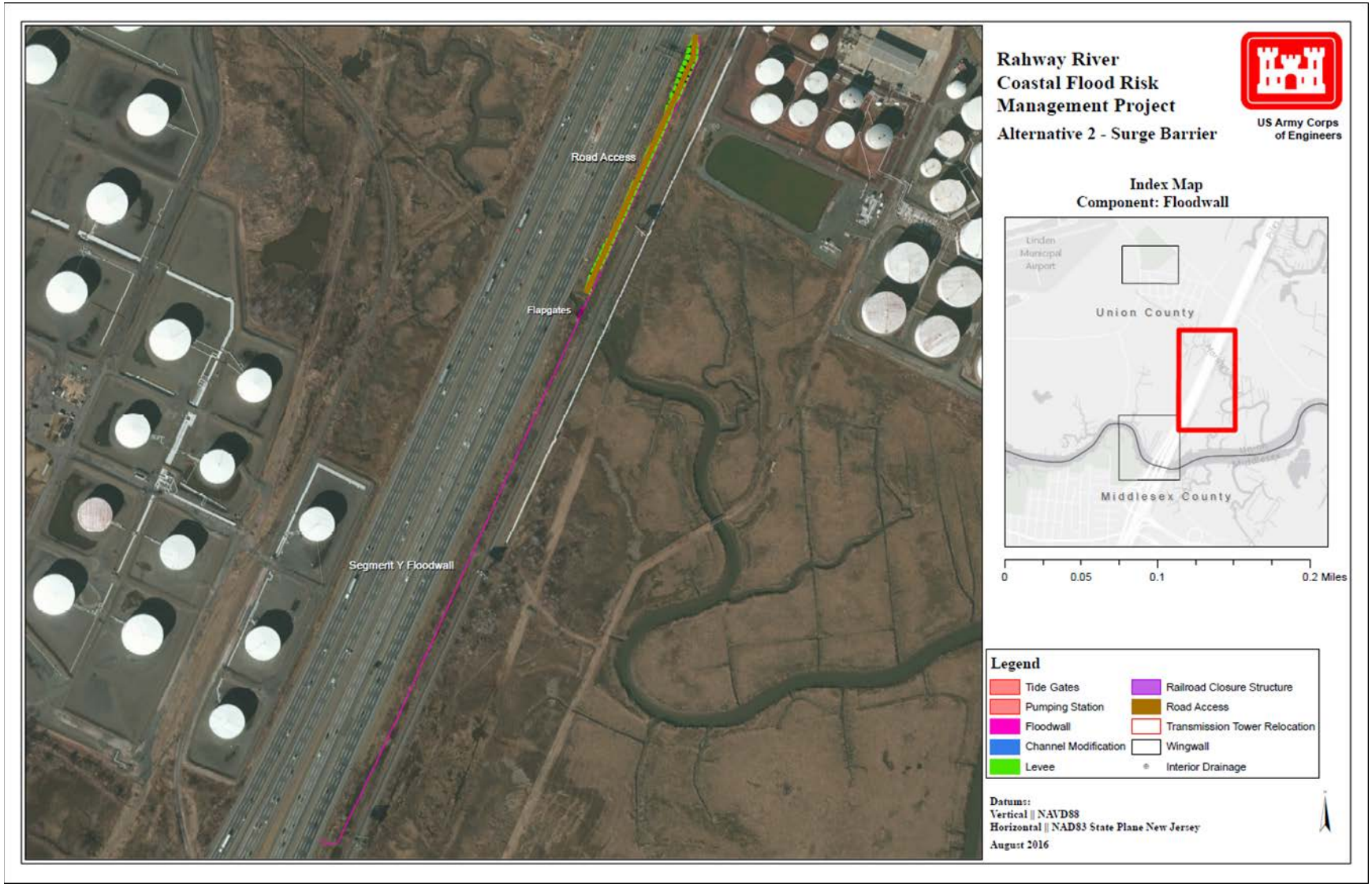


Figure 17. Alternative #2 – Floodwall along New Jersey Turnpike (Northbound Side)

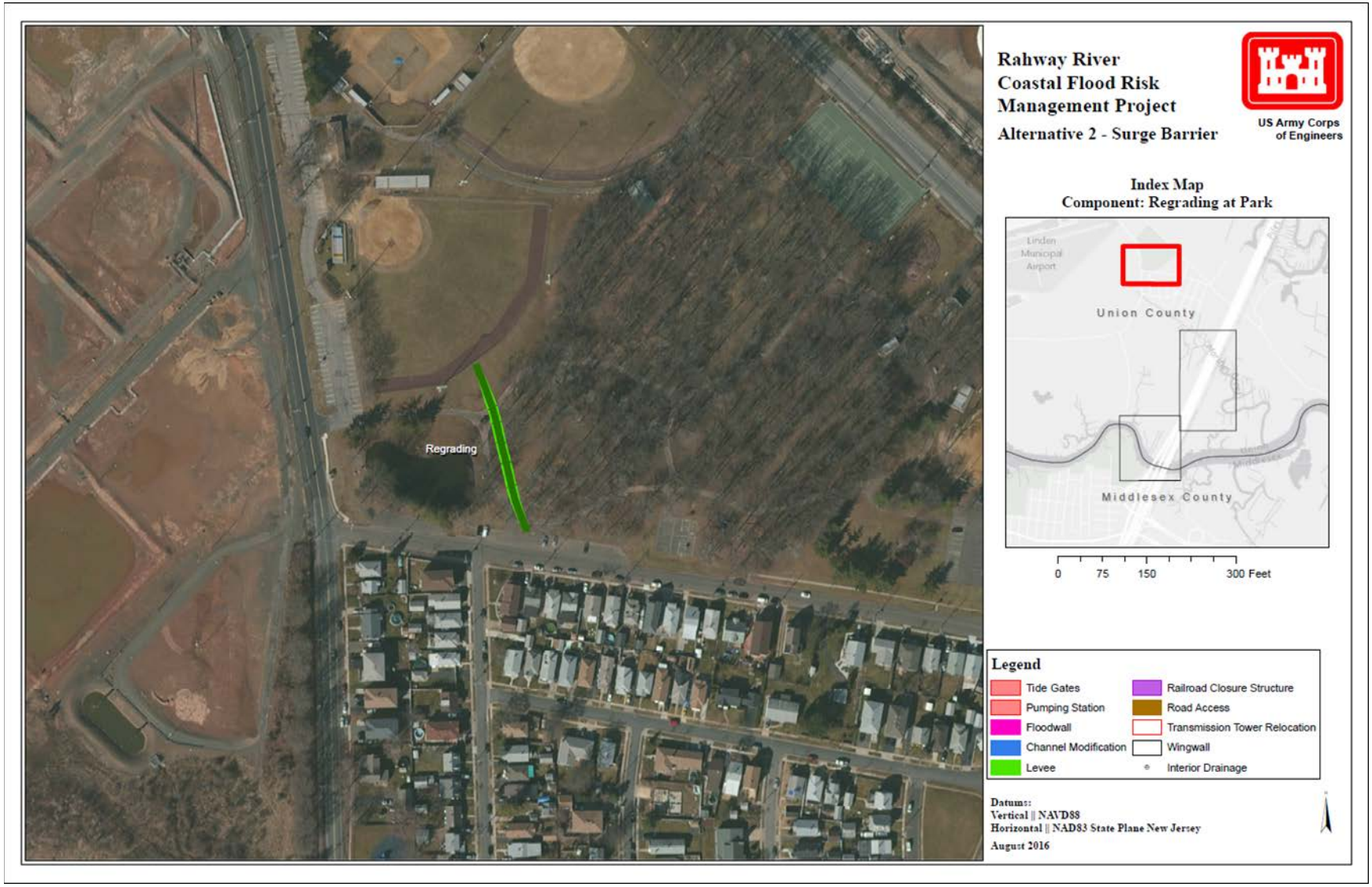


Figure 18. Alternative #2 – Regrading at Memorial Field Park

Alternative #2 - Hydraulic Analysis

This alternative was developed based on a design height of 13.0 ft NAVD ’88, which is approximately the future conditions 1% ACE event. All levees, floodwalls, and tide gates were designed to this height and evaluated based on their performance during the 1% ACE hypothetical event in HEC-RAS.

The pump station was designed based on guidance from EM 1110-2-1413 Hydrologic Analysis of Interior Areas (chapter 3), which describes the “minimum facility” of flood relief for storm drainage. Pump necessity was first determined based on the storage-elevation curve of the area of study (19). Given the lack of natural detention storage and the parallel functionality of a levee to a surge barrier, the minimum facility design concept was applied to pump capacity design. The language of the EM suggests that flooding “with project” cannot be any worse than “without project” conditions. In the area of the study, the “without project” WSEs cause damages beginning at approximately 5.25 ft NAVD ’88, which occurs below the 50% ACE (2-yr) event. The goal of pump design is to have enough capacity and efficiency to lower “with project” WSEs to “without project” WSEs. The pump was designed to decrease WSEs to 5.25 ft NAVD 88’ at approximately the 2% ACE coastal storm surge event or less.

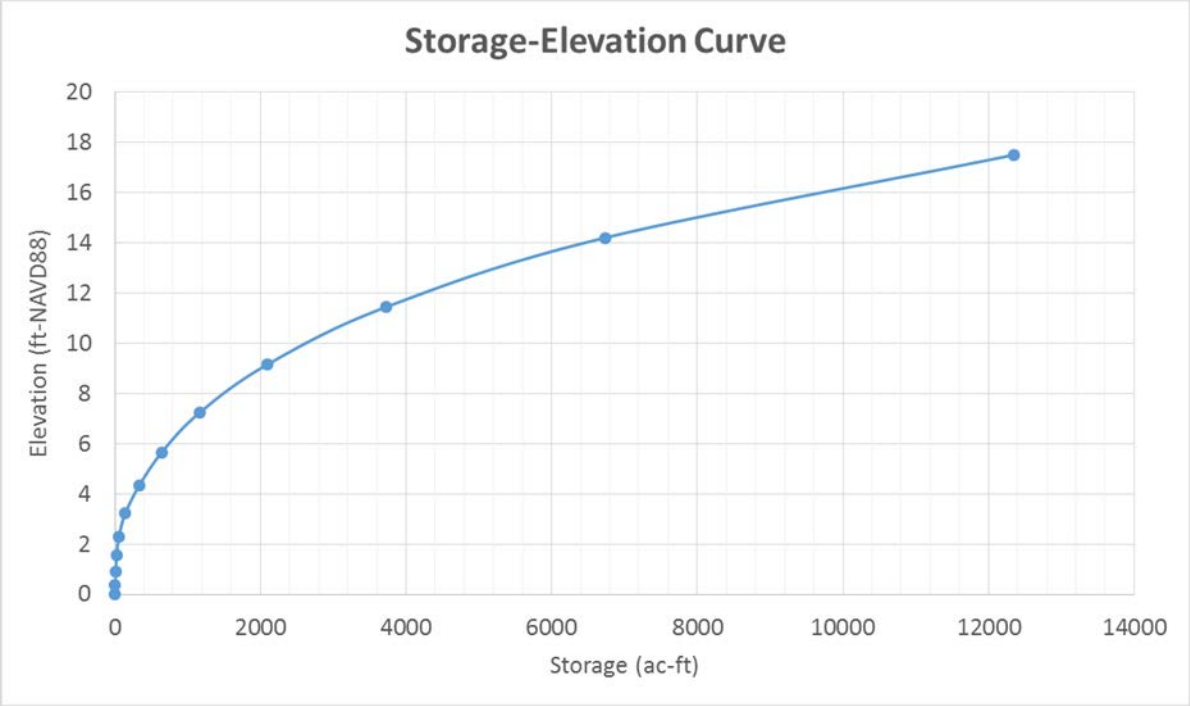


Figure 19. Storage–Elevation Curve Showing Capacity of Coastal Storm Surge Affected Portion of the Rahway River Basin

HEC-RAS hydraulic runs were used to create stage-frequency curves in order to determine the capacity and ramp-up/down elevations for pump operation. The feasibility stage pump capacity design was determined to be four 1,500 cfs pumps, having a total capacity of 6,000 cfs.

Non-Structural Analysis
Floodplains corresponding to a flood frequency of 10% and 2% annual chance exceedance (10 and 50 year events) were evaluated considering future conditions flows and boundary conditions. The analysis is based on fluvial-coastal storm surge joint-probability WSEs for these two events. Structures within the corresponding joint-probability floodplains were analyzed for treatment type based on structure type, condition, and build characteristics. Treatments for buildings were selected based on the USACE National Nonstructural/Flood Proofing Committee (NFPC) Flood Damage Reduction Matrix (March 2016).

Alternative #3a: 10% ACE Floodplain
Nonstructural measures were determined for approximately 577 structures (211 residential, 366 non-residential) contained in the 10% ACE (10-yr) floodplain. Results for the 10% ACE floodplain show that 257 structures will be treated and no treatment is recommended for the remaining 320 structures. This alternative requires approximately 33 ringwalls, each surrounding from one to 30 structures, varying in length from 300 to 3,500 linear feet, and varying in height above grade from 5 to 15 feet. All structures will be treated to an elevation of one foot above the 1% annual exceedance event, including sea level change. Non-structural treatments for the 10% ACE floodplain plan are summarized in Table 21.

Additional flood risk management measures would be required to mitigate backwater during fluvially influenced events. The WSEs at the confluence of Robinson's Branch and Rahway River down to Monroe Street were increased due to the constriction of flow by structural ringwalls. Proximity of ringwalls to the river, expansiveness of ringwalls, and minimal storage capacity contribute to the localized increases in flooding upstream. In this situation, mitigation for flooding was accounted for by including channel modification and bridge replacement at Monroe Street. Channel modification comprised of deepening approximately 3,300 linear feet along mainstem Rahway River and widening the river near Monroe Street Bridge, for a total dredged capacity of approximately 17,000 cy.

Alternative #3b: 2% ACE Floodplain
Nonstructural measures were determined for approximately 983 structures (561 residential, 422 non-residential) contained in the 2% ACE (50-yr) floodplain. Results for the 2% ACE floodplain show that 597 structures will be treated and no treatment is recommended for the remaining 386 structures. This alternative requires approximately 40 ringwalls, each surrounding from one to 62 structures, varying in length from 300 to 10,000 linear feet, and varying in height above grade from 5 to 15 feet. All structures will be treated to an elevation of one foot above the 1% annual exceedance event, including sea level change. Non-structural treatments for the 2% ACE floodplain plan are summarized in Table 21.

Additional flood risk management measures would be required to mitigate backwater during fluvially influenced events. Mitigation efforts would increase for Alternative #3b from Alternative #3a due to greater constrictions for longer reaches. Channel modification comprised of deepening approximately 4,500 linear feet along mainstem Rahway River, widening the river near Monroe Street Bridge, and deepening approximately 2,000 linear feet along South Branch from the existing levee upstream towards the railroad bridge. Bridge replacements and road raising would be required as well.

Table 21. Non-Structural Treatments for the 10% (10-yr) and 2% (50-yr) ACE Floodplains.

Nonstructural Flood Proofing Measure	Alt #3a: 10% ACE Floodplain			Alt #3b: 2% ACE Floodplain		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Dry Flood proofing	0	2	**2**	12	34	**46**
Dry Flood Proofing with Tank Anchoring	0	0	**0**	0	3	**3**
Wet Flood Proofing	10	1	**11**	66	1	**67**
Pump Replacement	0	3	**3**	0	3	**3**
Elevation	138	3	**141**	292	4	**296**
Ringwalls	47	53	**100**	92	90	**182**
Total of Structures	**195**	**62**	**257**	**462**	**135**	**597**

Alternatives Results

The improved hydraulic condition analysis shows that the alternative with the greatest flood risk reduction is Alternative #2. Reduction in WSE is up to 3.4 ft in the location of the Turnpike Bridge for Alternative #2. However, this alternative is the most costly of all the alternatives. Alternative #1 reduces WSE by about half a foot at the confluence with Robinson's Branch and South Branch, but only at smaller flood events. The reduction in WSE from "without project" WSEs to those of Alternatives #1 and #2 are seen in Tables 22 and 23.

Table 22. Decrease in WSE from "Without Project Condition for the 10% ACE (10-yr) Event.

Location	HEC-STA	W/O Project WSE (ft.)	Reduction in the 2% ACE WSE (ft.)	
			Alt #1	Alt #2
Rahway River at Rahway Water Supply Dam	34903.35	20.08	0.00	0.00
Robinson's Branch at Milton Lake Dam	8751.545	21.30	0.00	0.00
Robinson's Branch at Rahway Confluence	175.4458	13.07	0.61	0.87
Rahway River Levee at Milton Ave Bridge	25887.58	11.46	0.09	1.48
South Branch Upstream	11216.78	17.43	0.00	0.00
South Branch and Rahway River Confluence	210.7962	11.44	0.03	1.46
Rahway River at Turnpike Bridge	11792	11.04	0.00	2.60

Table 23. Non-Structural Treatments for the 10% (10-yr) and 2% (50-yr) ACE Floodplains.

Location	HEC-STA	W/O Project WSE (ft.)	Reduction in the 1% ACE WSE (ft.)	
			Alt #1	Alt #2
Rahway River at Rahway Water Supply Dam	34903.35	21.30	0.00	0.00
Robinson's Branch at Milton Lake Dam	8751.545	21.75	0.00	0.00
Robinson's Branch at Rahway Confluence	175.4458	14.56	0.43	0.43
Rahway River Levee at Milton Ave Bridge	25887.58	12.42	0.00	2.06
South Branch Upstream	11216.78	17.84	0.00	0.00
South Branch and Rahway River Confluence	210.7962	12.42	0.00	2.07
Rahway River at Turnpike Bridge	11792	12.33	0.00	3.41

An initial economic analysis and cost estimate collectively determined that a combination plan of nonstructural treatments and a levee segment would provide the greatest benefit to cost ratio. It was determined from the analysis that Alternative #2 did not produce a positive benefit-to-cost ratio within the entirety of the hydraulically dependent alternative. Nonetheless, Alternative #1 produced one levee segment with a positive BC ratio as determined by economic reach due to hydraulic independence. The pre-TSP economic analysis therefore determined that a nonstructural plan in conjunction with levee Segment D from Alternative #1 would be used for TSP determination. This combination plan and its modifications will be described in the following sections.

The Combination Plan

In order to reach an acceptable alternative for the TSP milestone, a re-evaluation of non-structural measures (i.e. ringwalls) based on new engineering guidelines was necessary. Although ringwalls were previously determined as a nonstructural measure, they are in fact “structural” measures analyzed and treated as structural features, i.e. floodwalls. Appropriate ringwall buffers for construction and inspection were included in the combination plan reassessment of the 10% ACE floodplain.

Alternative #4: 10% ACE Non-Structural Plan + Levee

This plan consists of a subset of structures within the 10% ACE floodplain nonstructural plan (Alternative #3a) and levee segment D from Alternative #1. Nonstructural measures were designed to the future conditions 1% ACE (100-yr) WSE plus one foot to account for water surface perturbations. The design height of the levee was evaluated at elevation 12.6 ft. NAVD ’88, consistent with the existing levees in the City of Rahway. Nonstructural recommendations on the protected side of this levee were omitted. This plan included a preliminary investigation of ringwall suitability, including the engineering feasibility given new guidelines and the economic practicability. A map of the combination plan can be found in Figure 20.

Alternative #4 determined nonstructural treatment for approximately 149 structures (131 residential, 18 non-residential) of the 577 structures (211 residential, 366 non-residential) contained in the 10% ACE (10-yr) floodplain. This alternative required 7 ringwalls, each surrounding from one to 5 structures, varying in length from 600 to 1,500 linear feet, and varying in height above grade from 5 to 10 feet. This is a reduction of 26 ringwalls from Alternative #3a, which in turn also reduced the need for channel modification and bridge replacement. No treatment was recommended at the time for the remaining 428 structures within the floodplain. A summary of the treated structures in Alternative #4 can be found in Table 24. Ringwall characteristics can be found in Table 25.

Table 24. Non-Structural Treatments for Alternative #4.

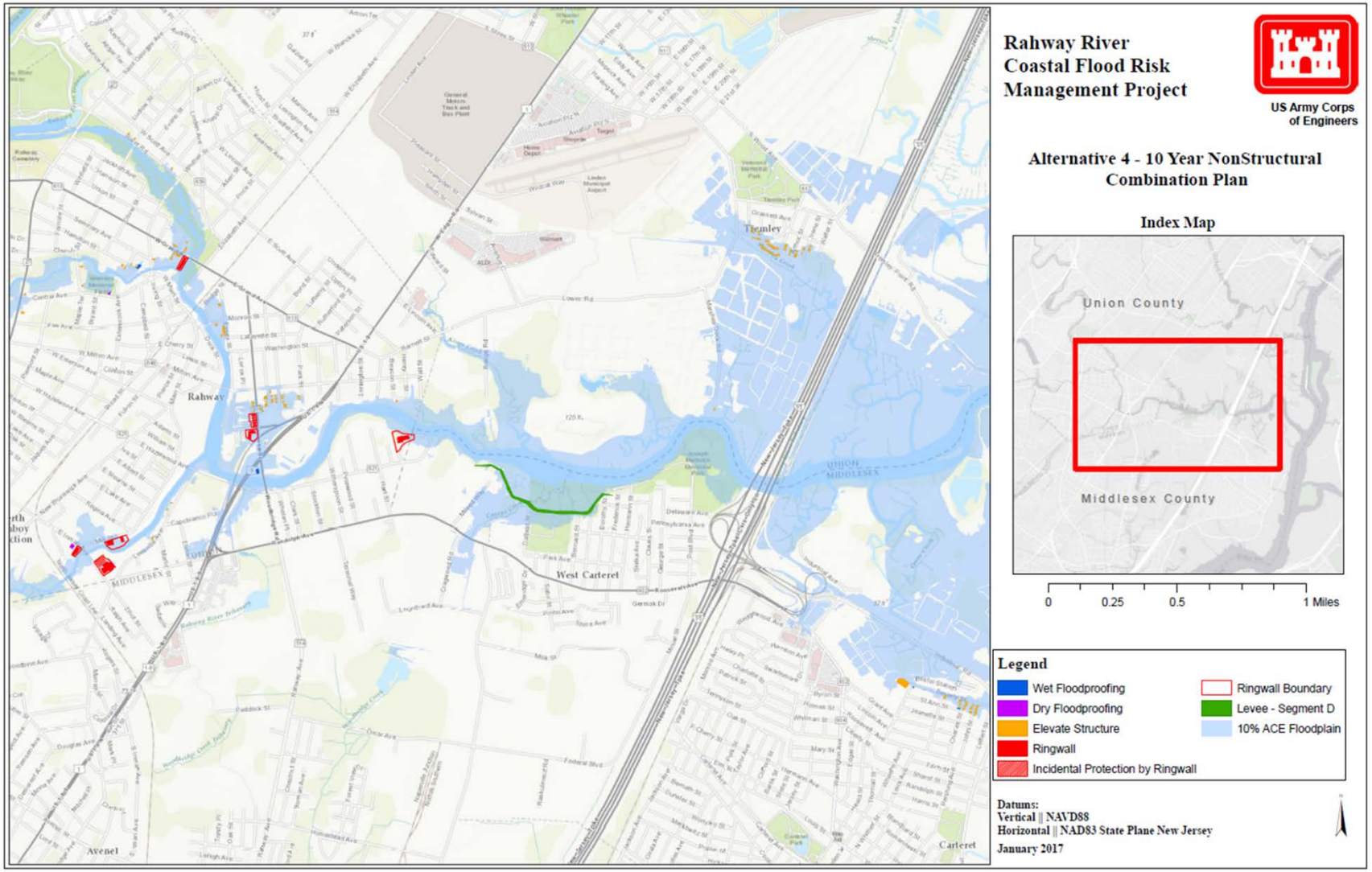
Nonstructural Flood Proofing Measure	**10% ACE Combination Plan**		
	Residential	**Non-Residential**	**Total**
Dry Flood Proofing	0	2	**2**
Wet Flood Proofing	1	3	**4**
Elevation	123	4	**127**
Demolish and Rebuild	1	2	**3**
Ringwall	6	7*	**13**
Total of Structures	**131**	**18**	**149**

* Structure is incidentally protected by ringwall. There is no associated cost with the additional structure but there are additional benefits.

Table 25. Characteristics of Ringwalls for Alternative #4.

Ringwall	**Structures within Ringwall**	**Avg Height of Ringwall (in feet)**	**Top of Ringwall (EL ft. NAVD)**	**Perimeter (ft)**
R001	2*	10	14.4	1226.362
R002	1	5	14.4	608.715
R003	2	10	14.4	1192.455
R004	1	10	14.3	1436.819
R005	1	10	14.4	858.846
R006	5	10	14.4	812.531
R007	1	10	16	789.54

* Structure is incidentally protected by ringwall. There is no associated cost with the additional structure but there are additional benefits.



*Note: This is the coastal storm surge inundation only. Representation does not include joint-probability WSEs.

Figure 20. Alternative #4 – Plan Overview

Alternative #4a: 10% ACE Non-Structural Plan + Levee, No Ringwalls
Alternative #4a consists of the 10% ACE floodplain nonstructural plan (Alternative #4) and a levee (Alternative #1 Segment D Levee) with the removal of all ringwalls from the nonstructural plan. The incremental justification of Alternative #4 resulted in all ringwalls being economically infeasible. As it was determined during the preliminary ringwall suitability evaluation in Alternative #4, structures given ringwall treatment had no other feasible nonstructural treatment method. The removal of all ringwalls would consequently remove all the structures enclosed by ringwalls from the plan entirely.

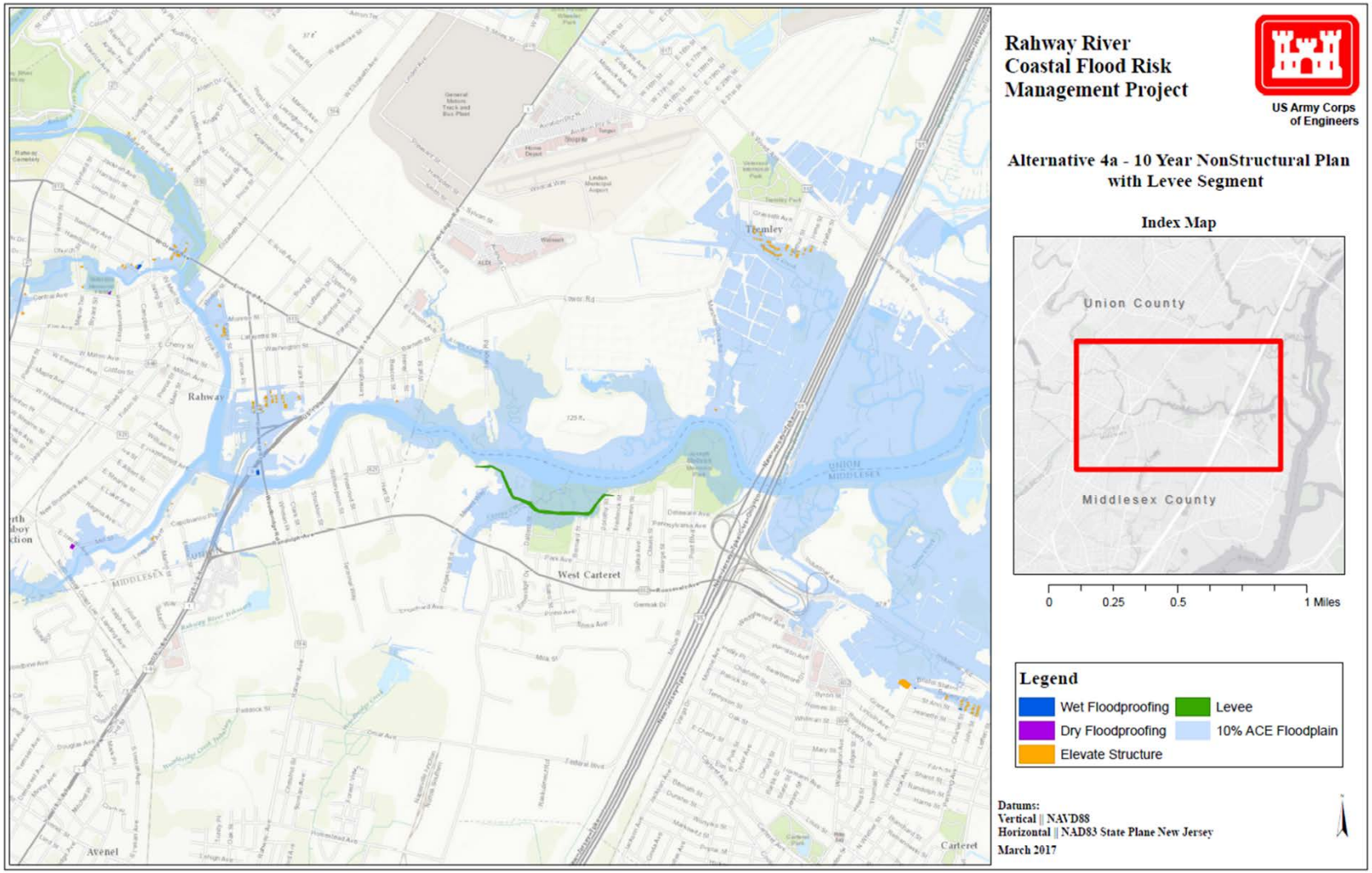
Alternative #4a thus determined nonstructural treatment for approximately 136 structures (125 residential, 11 non-residential) of the 577 structures (211 residential, 366 non-residential) contained in the 10% ACE (10-yr) floodplain. Nonstructural measures were designed to the future conditions 1% ACE (100-yr) WSE plus one foot to account for water surface perturbations. No treatment is recommended at this time for the remaining 441 structures within the floodplain.

The levee segment is 3,360 ft. long with a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft. The design height of the levee was evaluated at elevation 12.6 ft. NAVD ’88, consistent with the existing levees in the City of Rahway. The levee is located next to the right bank of the Rahway River, approximately 1.2 miles downstream of the confluence with the South Branch. The upstream end is located at the industrial/commercial area by Ardemore Ave., continuing downstream to Dorothy St. Nonstructural recommendations on the protected side of this levee were omitted.

Optimization of Alternative #4a is the next step of the hydraulic analysis, during which nonstructural treatments and the levee segment will be revisited for analysis at various flood frequency design heights. A map of this Tentatively Selected Plan can be found in Figure 21. A summary of the treated structures in Alternative #4a can be found in Table 26.

Table 26. Nonstructural Treatments for Alternative #4a.

Nonstructural Flood Proofing Measure	10% ACE Combination Plan		
	Residential	Non-Residential	Total
Dry Flood Proofing	0	2	**2**
Wet Flood Proofing	1	3	**4**
Elevation	123	4	**127**
Demolish and Rebuild	1	2	**3**
Total of Structures	**125**	**11**	**136**



Note: This is the coastal storm surge inundation only. Representation does not include joint-probability WSEs.

Figure 21. Alternative #4a – Plan Overview

4.9 Costs and Benefits for Alternatives

The costs for each alternative were estimated in order to compare alternatives and calculate the Benefit/Cost Ratio for evaluation purposes. Costs include planning, engineering and design, construction management, interest during construction and operation and maintenance. The construction cost estimates were developed in MCACES, Second Generation (MII) and based on current estimated quantities provided by hydraulics & hydrology, civil, and structural engineering disciplines and environmental and real estate mitigation costs. The cost estimates were developed from these quantities using cost resources such as RSMeans, historical data from similar construction features, and MII Cost Libraries. Contingency percentages were estimated for the alternatives using the Abbreviated Cost Schedule Risk Analysis (ARA), the template of which was provided by the Cost Mandatory Center of Expertise (MCX), located in the Walla Walla District of USACE. These contingencies were applied to the construction cost estimates to develop the Total Project First Cost. The construction schedule was developed based on the assumption that multiple crews would work simultaneously.

Planning, Engineering and Design

The costs were developed for all activities associated with the planning, engineering and design effort. The cost for this account includes the preparation of Design Documentation Reports and plans and specifications for each construction contract and engineering and planning support, including environmental compliance and monitoring, during construction through project completion. It includes all the in-house labor based upon work-hour requirements, material and facility costs, travel and overhead.

Construction Management

The costs were developed for all construction management activities from pre-award requirements through final contract closeout. These costs include the in-house labor based upon work-hour requirements, materials, facility costs, support contracts, travel and overhead. Costs were developed based on the input from the construction division in accordance with the Civil Works Breakdown Structure (CWBS) and include but are not limited to anticipated items such as the salaries of the resident engineer and staff, survey men, inspectors, draftsmen, clerical, and custodial personnel; operation, maintenance and fixed charges for transportation and for other field equipment; field supplies; construction management, general construction supervision; project office administration, distributive cost of area office and general overhead charged to the project. The work items and activities would include, but not be limited to: the salaries of all supervisory, engineering (including resident geologist and geological staff), office and safety field personnel; all on site expenses.

Interest During Construction

Interest During Construction (IDC) is the opportunity cost reflected by utilizing the funds for implementation of a project and associated with the foregone opportunity of investing the funds for other purposes. Average annual costs were determined based on investment costs, including IDC. The pre-base year costs were estimated using the Federal interest rate of 2.875% (FY17).

Operation, Maintenance, Repair, Rehabilitation, and Replacement

The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs were estimated to represent the anticipated annual costs necessary to maintain the project at full

operating efficiency throughout the project life. Following completion of the project, operation and maintenance of project facilities would be performed by the local cooperating agency in accordance with federal regulations and operations manual.

Estimated Average Annual Costs

Average annualized costs are based on an economic project life of 50 years and an interest rate of 3.125%. The annual charges include the annualized investment costs along with annual operation and maintenance costs.

Benefits of Alternatives

The alternatives were evaluated using the HEC-FDA model. Model output of damages was used to calculate the reduction in damages achieved by an alternative. A 50-year period (2021-2071) was analyzed and the FY17 discount rate of 2.875% was used to calculate present value (PV) of the damages. Price Levels used are October 2016. Below are the alternatives simulated in the HEC-FDA model.

- No Action (Without Project)
- Alternative #1: Levees and Floodwalls
- Alternative #2: Surge Barrier
- Alternative #3a & 3b: Nonstructural Measures + Barriers
- Alternative #4 & 4a: Levee Segment D + Nonstructural Measures

4.10 Evaluation and Comparison of Array of Alternative Plans

Evaluation and comparison of alternatives in the project area has been completed. Table 27 below displays the results of the benefit-cost analysis for the the overall alternatives.

Table 27. Economic Analysis for Overall Alternatives

	Equivalent Annual Damages		Equivalent	Equivalent			
	Without Project	With Project	Annual Benefits	First Cost	Annual Cost	Net Benefits	BCR
Alternative 1: Levee/Floodwall with Channel Modification	$17,526,500	$11,940,300	$5,586,200	$106,506,651	$4,760,697	$825,503	1.2
Alternative 2: Tidal Surge Barrier	$17,526,500	$11,181,100	$6,345,400	$988,808,637	$47,012,307	-$40,666,907	0.1
Alternative 3A:Nonstructural Treatment (10% Annual Chance Exceedance Floodplain)	$17,526,500	$8,849,000	$8,677,500	$623,323,356	$26,920,198	-$18,242,698	0.3
Alternative 3B: Nonstructural Treatment (2% Annual Chance Exceedance Floodplain)	$17,526,500	$7,840,000	$9,686,500	$973,143,314	$45,395,226	-$35,708,726	0.2
Alternative 4: Levee Segment D & Nonstructural Treatment (10% Annual Chance Exceedance Floodplain)	$17,526,500	$11,756,600	$5,769,900	$180,535,678	$7,736,246	-$1,966,346	0.7
Alternative 4A: Levee Segment D & Nonstructural Treatment without Ringwalls (10% Annual Chance Exceedance Floodplain)	$17,526,501	$13,138,401	$4,388,100	$66,900,321	$2,650,871	$1,737,229	1.7

Alternative costs and benefits at October 2016 price level, 2.875% discount rate
Annual Cost includes First Cost, IDC, and O&M

Table 27 indicates that Alternative 2: Surge Barrier lacks economic justification with a BCR of 0.14. Alternatives 3A, 3B, and 4 also lacked economic justification. Ringwalls within Alternative 3A were assessed structure by structure. Most ringwalls in Alternative 3A were removed via engineering judgement and practice when formulating Alternative 4, with seven ringwalls remaining within Alternative 4. However, subsequent incremental economic analysis was performed on the seven remaining ringwalls within Alternative 4, demonstrating that all seven ringwalls lacked incremental economic justification. The seven ringwalls in Alternative 4 were thus removed from Alternative 4 to form Alternative 4a. Table 28 displays the incremental economic analysis for the remaining seven ringwalls within Alternative 4.

Table 28. Incremental Economic Analysis for Ringwalls within Alternative 4

Segment	First Cost	Annualized Cost	Annualized Benefits	BCR	Net Benefits
Ringwall R001	$20,311,475	$901,334	$274,300	0.30	-$627,034
Ringwall R002	$9,846,845	$424,979	$89,200	0.21	-$335,779
Ringwall R003	$19,570,211	$841,500	$114,500	0.14	-$727,000
Ringwall R004	$23,513,359	$1,011,657	$244,700	0.24	-$766,957
Ringwall R005	$14,468,606	$623,159	$487,600	0.78	-$135,559
Ringwall R006	$13,919,317	$600,135	$46,600	0.08	-$553,535
Ringwall R007	$13,301,568	$574,616	$124,900	0.22	-$449,716
Total	$114,931,380	$4,977,380	$1,381,800	0.28	-$3,595,580

In addition, Alternative 1: Levee/Floodwall consists of four hydraulically separate segments identified as Segments A, B, C and D, each needing incremental justification. Table 29 displays the incremental economic analysis for the four segments.

Table 29. Economic Analysis for Alternative 1: Levee/Floodwall Segments

	Equivalent Annual Damages		Equivalent		Equivalent		
	Without Project	With Project	Annual Benefits	First Costs	Annual Costs	Net Benefits	BCR
Segment A	$17,526,500	$14,632,600	$2,893,900	$71,406,967	$3,225,110	-$331,210	0.90
Segment B	$17,526,500	$17,464,100	$62,400	$11,958,487	$522,185	-$459,785	0.12
Segment C	$17,526,500	$17,481,500	$45,000	$4,938,263	$212,027	-$167,027	0.21
Segment D	$17,526,500	$15,182,900	$2,343,600	$18,202,934	$801,376	$1,542,224	2.92
Total	$17,526,500	$12,181,600	$5,344,900	$106,506,651	$4,760,698	$584,202	1.12

*Without Project Equivalent Annual Damages is equivalent to the annual damage pool for the total project area.

Table 29 illustrates that only levee Segment D is economically justified and is thus identified as the TSP project element for that area. As stated previously Alternative 4 is a mix of ringwalls and nonstructural measures (in addition to the Segment D levee). When the cost of the ringwalls was removed, the nonstructural elements maximized net benefits in areas where flood risk management is not provided by the Segment D levee. Nonstructural treatment in the levee Segment D area provided lower net benefits (~$1.1M in the 10% ACE floodplain) than the Segment D levee. The economics of nonstructural treatment within the 10% ACE floodplain is shown in Table 30.

The TSP is thus identified as Segment D levee/floodwall as found in Alternative 1 in combination with nonstructural measures within the 10% ACE floodplain in the remainder of the project area. Table 30 displays the economic analysis for the TSP.

Table 30: Economic Analysis for Unprotected Areas Reach

	Equivalent Annual Damages		Equivalent		Equivalent		
	Without Project	With Project	Annual Benefits	First Costs	Annual Costs	Net Benefits	BCR
Nonstructural Treament (10% Annual Chance Exceedance Floodplain)	$17,526,500	$15,488,600	$2,037,900	$47,712,151	$1,850,455	$187,445	1.10
Segment D Levee/Floodwall	$17,526,500	$15,176,200	$2,350,300	$17,892,147	$808,837	$1,541,463	2.91
Total	$17,526,500	$13,138,300	$4,388,200	$65,604,298	$2,659,292	$1,728,908	1.65

Price levels of all alternatives will be updated to the latest common year upon submission of the Final Integrated Report/Environmental Assessment with Appendices.

Identifying a Tentatively Selected Plan

The alternative that maximized net benefits for each independent reach was selected as an element of the Tentatively Selected Plan (TSP). Alternative 4a (10% ACE Non-Structural Plan + Levee, No Ringwall) is identified as the TSP. Alternative 4a would provide coastal storm risk management for portions of the municipalities of Carteret, Linden, Rahway and Woodbridge through implementation of the Segment D levee and nonstructural measures within the 10% ACE floodplain.

As the TSP is optimized later in the study phase the Segment D levee will be examined at different levels of flood risk management. The nonstructural measures will be optimized by considering nonstructural treatment of structures in different floodplains than the 10% ACE floodplain.

Initial construction of the Segment D levee is estimated to take from October 2019 until September 2021. Initial construction of the nonstructural measures are estimated to take place in that time period. The period of analysis (2021-2071) is assumed for the economics evaluation in this study.

Chapter 5.0 Tentatively Selected Plan*

5.1 Proposed Action/Plan Components

The Tentatively Selected Plan (TSP), which is also the National Economic Development (NED) Plan, consists of construction of a levee segment in combination with implementation of nonstructural measures within the project area. The TSP plan is illustrated in Figure 29. Additional detail on the TSP is included in the appendices.

Further evaluation and optimization of the tentatively selected plan will occur after public and agency review of the Draft Integrated Feasibility Report/Environmental Assessment (DIFR/EA) and the appendices as the study progresses. This will include refinements to the plan and design.

TENTATIVELY SELECTED PLAN FEATURES

The TSP has been identified as Alternative 4a: 10% ACE Non-Structural Plan + Levee, No Ringwalls. Alternative #4a consists of nonstructural measures within the 10% ACE floodplain nonstructural plan and a levee (Alternative #1 Segment D Levee).

Alternative #4a consists of nonstructural treatment for approximately 136 structures (125 residential, 11 non-residential) of the 577 structures (211 residential, 366 non-residential) contained in the 10% ACE (10-yr) floodplain. Nonstructural measures were designed to the future conditions 1% ACE (100-yr) WSE plus one foot to account for water surface perturbations. No treatment is recommended at this time for the remaining 441 structures within the floodplain.

The Segment D Levee is 3,360 ft. long with a 12 ft. top width and one vertical to three horizontal (1:3) side slopes. The average height is approximately 7.5 ft. The design height of the levee was evaluated at elevation 12.6 ft. NAVD ’88, consistent with the existing levees in the City of Rahway. The levee is located next to the right bank of the Rahway River, approximately 1.2 miles downstream of the confluence with the South Branch. The upstream end is located at the industrial/commercial area by Ardemore Ave., continuing downstream to Dorothy St. Nonstructural recommendations on the protected side of this levee were omitted.

Optimization of Alternative #4a is the next step of the hydraulic analysis, during which nonstructural treatments and the levee segment will be revisited for analysis at various flood frequency design heights. Table 31 contains details pertaining to the treatment of individual structural in the project area. Figure 22 illustrates the different elements of the TSP, including the Segment D levee and structures selected for nonstructural treatment. Figure 22 illustrates the type of nonstructural measures per structure by color coding.

Table 31. Nonstructural Treatments

Nonstructural Flood Proofing Measure	10% ACE Combination Plan		
	Residential	Non-Residential	Total
Dry Flood Proofing	0	2	**2**
Wet Flood Proofing	1	3	**4**
Elevation	123	4	**127**
Elevation - Demolish and Rebuild	1	2	**3**
Total of Structures	**125**	**11**	**136**

The above dimensions and requirements will be refined by further project evaluation, agency reviews, and optimization as the study progresses.

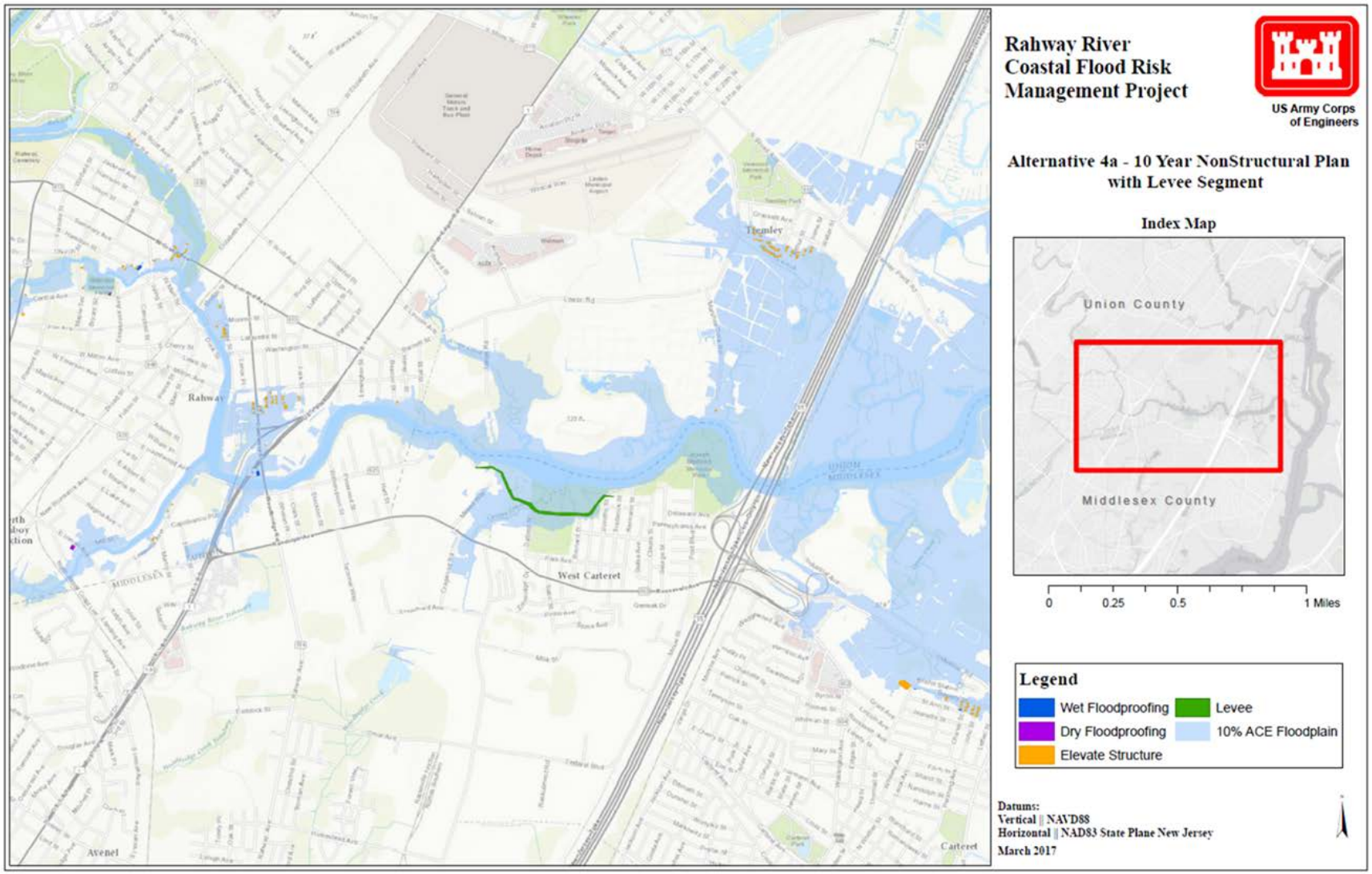


Figure 22. Alternative #4a – TSP Plan Overview

Construction Method: Initial construction of the Segment D levee is estimated to take from October 2019 until September 2021. Initial construction of the nonstructural measures are estimated to take place from April 2020 to June 2021. Construction years are assumed for the economics evaluation in this study, but are subject to future project approval and funding requirements.

Real Estate Requirements. USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. Details are provided in Appendix E (Real Estate Plan).

5.2 TSP Refined Cost Estimate

The costs presented at the TSP were developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) program. The MII cost estimate used RSMeans, MII Cost Libraries, and vendor quotations. The project contingencies were developed through the Abbreviated Risk Analysis (ARA) tool provided by the USACE Mandatory Center of Expertise. The summary of the results of this risk analysis, and more detail on the cost estimate, can be viewed in Appendix D (Cost Engineering).

The project cost estimate is broken out by cost component in Table 32. This includes planning, engineering and design, construction management, interest during construction and operation and maintenance (contingencies are included). The TSP First Cost is $66,900,000 and the TSP Total Project Cost is $70,930,000.

Table 32. TSP Refined Cost Estimate[4]
(October 2016 Price Level, FY17 2.875% discount rate, Rounded to 1000)

Account/Cost Component	TSP First Cost (Alternative 4a)	TSP Total Project Cost (Alternative 4a)
Total Project Cost		
01 – Lands and Damages	$2,192,000	$2,324,000
06 – Fish & Wildlife Facilities	$1,914,000	$2,030,000
11 – Levees & Floodwalls	$10,297,000	$10,919,000
18 – Cultural Resource Preservation	$3,321,000	$3,522,000
19 – Buildings, Grounds & Utilities	$32,989,000	$34,982,000
30 – Planning, Engineering & Design	$11,668,000	$12,084,000
31 – Construction Management	$4,519,000	$5,069,000
Estimated Total Project Cost	**$66,900,000**	**$70,930,000**

[4] Initial construction is cost shared 65% Federal and 35% non-Federal and continuing construction is cost shared 50% Federal and 50% non-Federal. See Section 9.2 for cost apportionment.

*Note: These costs will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

Operation, maintenance, repair, rehabilitation, and repair (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of requirements. This would consist of periodic project surveillance and maintenance. The OMRR&R cost is estimated at $51,484/year.

5.3 Refined Annual Cost and Benefit of the TSP

Table 33 states the cost and benefit for the TSP. The BCR for the TSP is calculated to be 1.7.

Table 33. Refined TSP, Annual Benefit and Cost Summary*
(October 2016 Price Level, FY17 2.875% discount rate)

	TSP
First Cost	$66,900,321
Interest During Construction	$1,598,186
Total Investment Cost	$68,498,507
Annual Investment Cost	$2,599,387
Annual O&M	$51,484
Annual Cost	$2,650,871
Annual Without Project Damages	$17,526,500
Annual With Project Damages	$13,138,400
Annual Benefits	$4,388,100
Net Benefits	$1,737,229
Benefit Cost Ratio	1.7

*Note: The Benefit-Cost Ratio will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

5.4 Risk and Uncertainty Analysis

Risk and uncertainty has been explicitly factored into the economic analysis of this project. A statistical risk based damage model, Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA), was used in this study to formulate and evaluate the project in a life-cycle approach. HEC-FDA integrates the engineering and economic analyses and incorporates uncertainty in both physical parameters and storms, which enables quantification of risk with respect to project evolution and economic costs and benefits of project implementation. For more information please refer to Appendix B – Economics. For information on risk and uncertainty with respect to hydrology and hydraulics please refer to Appendix C – Hydrology and Hydraulics.

5.5 Economic, Environmental, and Other Social Effects

In reducing damages from future events, the TSP contributes to National Economic Development. National Environmental Restoration considerations are addressed in Chapter 6 (Environmental

Effects) of this report. As for Other Social Effects (OSE), the project would maintain the viability of routes of transportation, including emergency and other vital services in the 1% ACE floodplain behind the Segment D levee. Implementation of the project could induce Regional Economic Development (RED) benefis in the area as residents and business owners may be able to allocate resources and spending on other goods and services than repairing and replacing structures or goods damaged by flooding.

Residual risks associated with the TSP includes remaining average annual damages of $13,138,300 out of a total average annual damage pool of $17,526,500. The average annual damage pool is for the 0.2% ACE (500 yr) floodplain and this residual damage pool includes expected average annual damages to structures and other infrastructure associated with the chemical and petroleum facilities. Critical infrastructure in the remainder of the project area would not be significantly affected from the TSP as nonstructural measures would not alter the floodplain. Figure 23 illustrates the critical infrastructure overlaid on an aerial view of the project area.

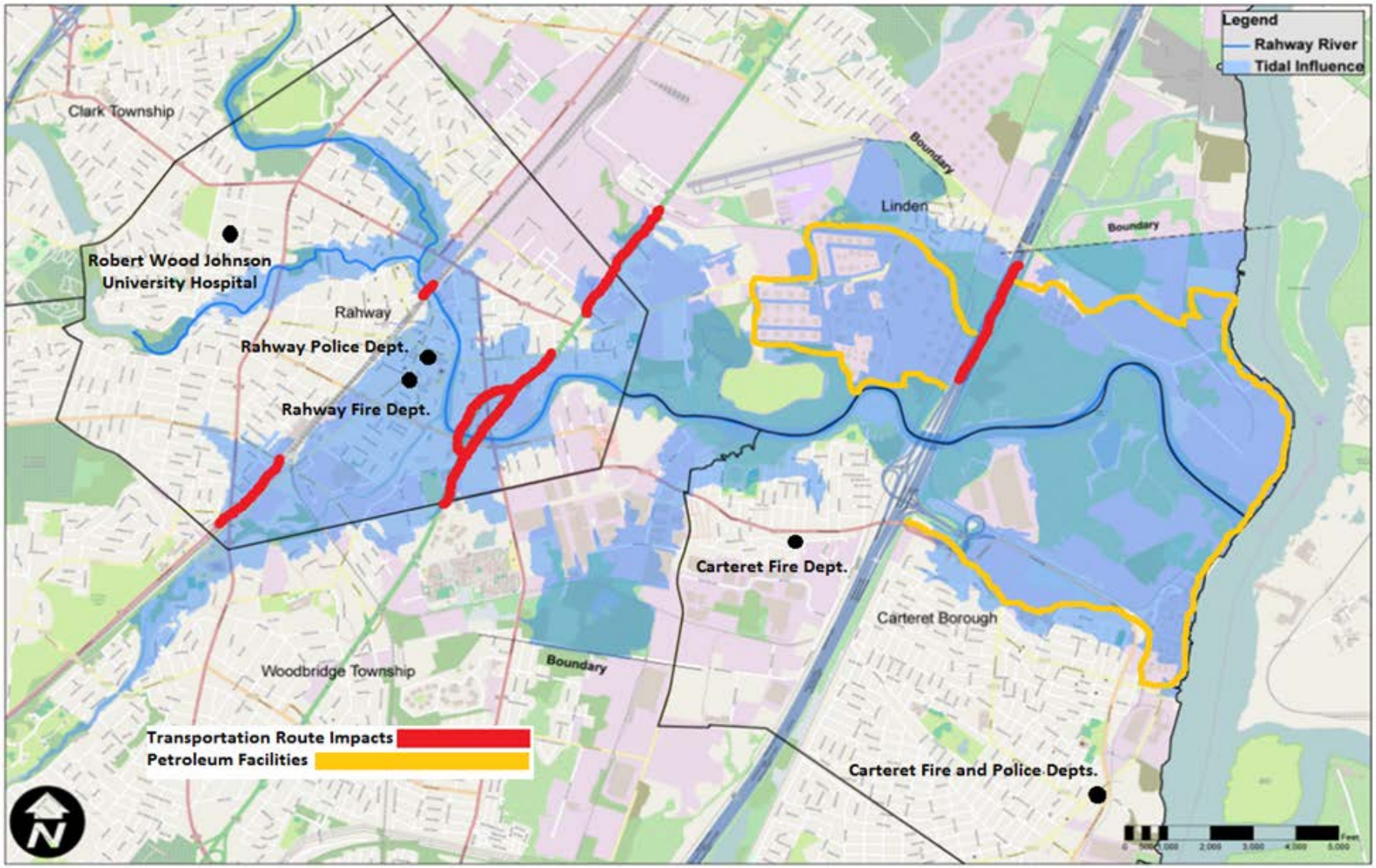


Figure 23. Critical Infrastructure within the Project Area

Chapter 6.0 Environmental Effects of the TSP*

This chapter discusses the potential positive and adverse environmental effects and consequences resulting from implementation of the Tentatively Selected Plan (TSP). The effects of the TSP are directly compared against the baseline Future Without Project /No Action alternative conditions as described in Section 4.4.2.

In addition to discussing potential beneficial and adverse environmental effects, this chapter outlines potential mitigation measures for adverse impacts and potential adaptive management methods that may be implemented to ensure success of the mitigation. In accordance with the Council of Environmental Quality NEPA regulations, mitigation includes: (a) Avoiding the impact by not taking a certain action or parts of an action; (b) Minimizing the impact by limiting the degree or magnitude of the action and its implementation;(c) Rectifying the impact by repairing, rehabilitating, or restoring the effected environment;(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (e) Compensating for the impact by replacing or providing substitute resources or environments.

6.1 Land Use

The proposed action will have a short term minor impact on residential and commercial land use around temporary workspaces during construction. Permanent easements will be acquired from property owners within the footprint of the levee and the 15 ft vegetation free zone that is required by Engineering Technical Letter (ETL) 1110-2-583 Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures to enable inspection and operation and maintenance activities.

Approximately 2,000 ft of the levee is located within the Joseph Medwick Memorial Park. There will be restrictions on park use during construction. However, the levee is situated in a location that will not affect or change the use of the park and its facilities once it is completed. Further discussion regarding the impacts to the park including is included in Section 6.10.1 Green Acres.

The remainder of the levee is located on private property. The downstream portion of the levee is located near homes. In addition to maintain a 15 ft woody vegetation free zone from the levee, the ETL 1110-2-583 also requires certain restrictions from property owners such as not putting permanent structures (e.g. sheds, above ground/underground pools). The landowner will be compensated fair market value for the easement obtained. The upstream portion of the levee will be located on the portions of the property that are not expected to interfere with the normal use of the property.

There will be no permanent changes to land use for the properties that are candidates for the nonstructural measures.

In general, the implementation of the proposed action will likely produce long term benefits by reducing flood risk and future damage to residential, manufacturing/industrial, commercial/office, transportation/utilities and open space land uses located within the project area.

Mitigation

Disturbed areas will be restored and their use returned to pre-construction conditions. Mitigation measures proposed to minimize the impacts the levee will have to the use of the Joseph Medwick Memorial Park is discussed in Section 6.11.1 Green Acres.

6.2 Topography, Geology and Soils

6.2.1 Topograhy and Geology

The current topography of the area within the footprint of the levee is very flat with minimal grade and an average elevation of 6 ft above sea level. The height of the levee will have an average height of 12.6 ft with a side slope grade of 3:1. Therefore, the construction of the levee will change the topography in the immediate. This modification will be limited to the immediate footprint of the levee and is necessary to provide the necessary storm risk management.

For the non-structural measures proposed, grading may be required around the foundation and potentially the lot. The topographical changes are expected to be negligible.

No short or long term adverse impacts to geology from implementation of the proposed action is anticipated.

6.2.2 Soils

The interior of the levee will be constructed with an impermeable clay core to prevent seepage. Compacted fill material is typically used for the levee exterior. Geotechnical borings of the site to determine the suitability of the soils to be used for the levee will be conducted during the Preconstruction Engineering Design (PED) Phase. However, in-situ soils frequently do not meet the geotechnical specifications for the impermeable clay core and/or the fill material for the exterior levee construction, requiring the appropriate material to be imported from an approved, permitted, off-site source.

Any importation of soils to construct the levee could represent a change in the existing soil type within the immediate footprint of the levee. This modification is necessary to maintain the structural integrity of the levee and the desired level of coastal storm risk management. In approximately 70% of the total area that will be impacted by the levee, the soils have already experienced some level of disturbance or conversion to pavement/asphalt associated with development. Therefore

Staging areas also will sustain short-term minor impacts during construction activities but will be restored following construction.

No significant impacts to soils as a result of implementation of the non-structural measures in the project area is expected.

Prime Farmland

The proposed action occurs in an urbanized setting that does not include any additional land uses related to agriculture or silviculture. Therefore, significant adverse impacts to Prime Farmland soils will not occur.

Hydric Soils

A portion of the proposed levee is located within areas that have soils that meet hydric soil criteria (Refer to Figure 3 in Appendix A.1). Because there are specific requirements for the type of soil used to construct levees, fill material that meets the construction specifications will be imported in

to construct the levee. This will constitute as a change in soil type and will impact hydric soils. However, this impact is limited to the footprint of the levee as is necessary to achieve the desired storm protection. No adverse impacts to hydric soils beyond the levee footprint are expected.

Mitigation Measures

An Erosion and Sediment Control Plan will be developed and submitted to the Somerset-Union Conservation and Freehold Conservation Districts for approval prior to construction the proposed project. Best management practices including but not limited to silt fence, turbidity curtains and temporary seeding will be implemented to reduce soil erosion within the project footprint. Following completion of modifications and structures, temporary work locations will be restored to pre-construction conditions.

6.3 Water Resources

6.3.1 Surface Water

The proposed levee extends over Casey's Creek. Casey's Creek is a tidally influenced tributary that begins at Randolph Avenue and flows for approximately 2,700 ft before discharging into the Rahway River. There are two catch basins on Randolph Avenue that directs stormwater discharge from the road and into Casey's Creek. The upper portion resembles a drainage ditch with ephemeral flow created by stormwater discharge and high tides. The channel is overgrown with invasive vegetation such phragmites, Japanese knotweed and tree of heaven. Based on a review of past aerials, the creek width has been significantly reduced, more than likely due to sedimentation, fill activities associated with development, and the overgrowth of vegetation. Approximately 1,500 ft downstream from its origin at Randolph Avenue, characteristics of the creek becomes more reflective of a natural tidal creek with mudflats and high marsh and low marsh wetland complexes. The levee is located in the vicinity where Casey's Creek transitions from a drainage ditch to a tidal creek.

Approximately 200 linear feet of the creek will be modified through the installation of the levee and associated drainage structure. The drainage structure will consist of a concrete culvert containing a flap gate. The flap gate will remain open during normal flows and will only be closed prior to storm events.

In compliance with the federal objective of no net loss of open water/wetland resources, the District will be evaluating the on-site restoration of 200 linear feet of tidal creek within the wetland complex in which Casey's Creek is located. The goal of the restoration is to improve tidal flow through the realignment or modification of either Casey's Creek or one of the smaller tidal tributaries within the wetland complex.

The implementation of nonstructural measures will have no adverse impacts to the Rahway River or associated tributaries.

Mitigation

Discussions of water resources mitigation, monitoring and adaptive management are described in Section 6.3.2 below.

6.3.2 Water Quality and Aquatic Habitat

The installation of the levee drainage structure in Casey's Creek will convert approximately 200 linear feet of natural channel with a silt/clay substrate and shorelines vegetated with herbaceous plant species to an enclosed concrete pipe. The conversion of the 200 ft of channel represents a permanent loss of natural open water habitat that may be used by fish and wildlife resources that inhabit or utilize the area. Although a flap gate will be installed in the drainage structure and will remain open during normal flows, the enclosed nature of the drainage structure may deter movement of some fish and benthic resources to the upstream portions of Casey's Creek. However, the degraded habitat conditions of the upper portion of Casey's Creek does not provide adequate aquatic habitat and would unlikely be used by many aquatic resources.

Casey's Creek is located within a 23 acre wetland complex that includes other smaller, tidal tributaries. The total linear footage of available tidal creek habitat within the wetland complex, including the portion of Casey's Creek that is downstream of the proposed levee, is 2,400 feet. The levee and associated drainage structure in Casey's Creek will also permanently impact approximately 0.14 acres of mudflat habitat. Excluding the 0.14 acres of mudflat impacted by construction of the levee, the wetland complex has approximately 1.3 acres of mudflat habitat.

As mentioned in Section 6.3.1, the District will be evaluating on-site restoration or enhancement of either Casey's Creek or to one of the smaller tributaries within the wetland complex and on-site restoration of mudflat habitat. In accordance with the Corps Civil Works Planning Policy, during optimization of the TSP the District will use the Evaluation of Planned Wetlands model to assess the functions and values of the segment of Casey's Creek and the mudflat habitat being impacted and will conduct a cost analysis to determine the appropriate level of mitigation required (Bartoldus, et al, 1994). For the purposes of the draft FR/EA, the District is assuming the restoration of 200 linear feet of tidal creek and 0.14 acres of mudflat habitat.

The availability of other tidal creek and mudflat habitat within the wetland complex in combination with the proposed mitigation will result in no significant adverse impacts aquatic habitat.

Construction of the levee and open water and wetland mitigation may create short term, minor water quality impacts within the immediate project area. The implementation of erosion and sediment best management practices such as turbidity curtains will minimize transport of sediment downstream. The installation of the drainage structure and construction of the portion of levee extending over Casey's Creek will be conducted in dry conditions utilizing cofferdams or a temporary diversion culvert. The flap gate will remain open during normal flows and the culvert will be placed at a grade to maintain flow of the creek. Therefore, there will not be any permanent adverse impacts to water quality as a result of the proposed project. There may be minor improvements to water quality through the restoration of 200 linear ft of tidal creek through the improvement of tidal flows.

It is expected that through the implementation of erosion and sediment control best management practices, that the Rahway River will not be impacted. In addition, the construction of the levee and proposed open water/wetland mitigation will not affect the use of the Rahway River as a water

source for the City of Rahway given that treatment already occurs and the treatment plant is approximately three miles upstream from the proposed levee.
The implementation of the nonstructural measures as proposed will not have any impacts on water quality or aquatic habitat.

Mitigation
To compensate for the permanent impact of 200 feet of open water, the District is will be evaluating on-site restoration or enhancement of either Casey's Creek or to one of the smaller tributaries within the wetland complex.

The District will be performing a habitat assessment using the Evaluation of Planned Wetlands model in the late spring/early summer 2017 to determine habitat value and mitigation needs. As per the Corps Civil Works Planning policy, the exact mitigation requirements will be conducted during optimization of the TSP. Further discussion of the proposed mitigation is located in Appendix A.9.

Monitoring and Adaptive Management
Refer to Appendix A.9 for full description of the monitoring procedures and potential adaptive management measures that could be employed to achieve mitigation success.

6.3.3 Wetlands
The proposed levee is located along the upper boundary of a 23 acre wetland complex consisting of several wetland habitat types. In absence of formal wetland delineations, it is assumed that five acres of wetlands will be impacted by construction of the levee. Specific wetland types being impacted by the construction of the levee and implementation of the required 15 ft vegetation free zone include approximately 1.8 acres of phragmites dominated high marsh, 2.3 acres of low marsh, 0.50 acres scrub-shrub deciduous wetland and 0.40 acres of managed wetland (Refer to Figure 4 in Appendix A.1). Formal wetland delineation surveys will be conducted in the PED Phase of the project to determine actual impacts.

In compliance with the federal objective of no net loss of wetlands, the District will be evaluating on-site restoration of wetland habitat to compensate for the permanent loss of the five acres of wetland resulting from the levee construction. In accordance with the Corps Civil Works Planning Policy, during optimization of the TSP the District will use the Evaluation of Planned Wetlands model to assess the functions and values of the wetlands impacted and conduct a cost analysis to determine the appropriate level of mitigation required.

The wetland complex has approximately six acres of high marsh dominated by monotypic stands of phragmites. For the purposes of the draft FR/EA, this area is considered for the potential restoration of four acres of low marsh system. In addition, there is a 0.68 acre stand of phragmites that will be evaluated for the potential restoration of deciduous scrub shrub wetland. Compensation for the 0.40 acres of permanent loss of managed wetland will either involve restoration of low marsh wetland or deciduous scrub shrub wetland.

Approximately 0.77 acres of predominantly phragmites dominated high marsh wetlands and low marsh wetlands will experience temporary impacts during construction. These areas will be

restored with native vegetation after construction is completed. In areas where phragmites dominates, elevation changes through excavation may occur to manage its reestablishment.

The area on the landside of the levee has been extensively modified to create recreational infrastructure (asphalt walking trail, athletic fields) within the Joseph Medwick Memorial Park. Therefore, the area on the landside of the levee identified as managed wetlands is presumed have experienced such extensive modifications that it no longer functions as wetland and that the levee will not cause any indirect impacts to these wetlands that require compensatory mitigation.

No wetlands will be impacted by the implementation of the proposed nonstructural measures.

Mitigation

During construction of the levee and open water and wetland mitigation, standard erosion and sediment control BMPs will be implemented to reduce the potential adverse impacts to wetland resources. Where equipment must be operated in wetlands, wetland access/anti-tracking mats will be used to reduce further damage to wetlands.

To compensate for the permanent loss of the five acres of wetlands described above, the District is proposing to conduct on-site wetland restoration. Further discussion of the mitigation plan is located in Appendix A.9.

Monitoring and Adaptive Management

Refer to Appendix A.9 for full description of the monitoring procedures and potential adaptive management measures that could be employed to achieve mitigation success.

6.3.4 Tidal Influences

The levee is set back from the Rahway River and will not interfere with the river's normal daily tidal fluctuations. However, it will limit inundation of developed areas by coastal storm surge for up to a 100-yr coastal storm event. The flap gate in the levee drainage structure located in Casey's Creek will remain open during normal flows and will only be closed prior to storm events. The intent of the wetland and open water mitigation is to restore natural tidal creeks and low marsh wetland by lowering elevations and provide better overall tidal inundation and circulation within the project area. The alteration of on-site tidal influences is necessary to manage coastal storm risk as well as improve the hydrology for salt marsh habitat restoration. Significant adverse on-site and off-site impacts are not expected.

The nonstructural component will not have any effect on tidal influences although it will provide protection to treated structures against coastal storm surge for up to a 100-yr coastal storm event.

6.4 Vegetation

6.4.1 Uplands and Riparian Corridor

Approximately 0.70 acres of upland vegetation in the form of shrubs and trees will be cleared to construct the levee and the 15 ft vegetation free zone on either side of the levee as required by ETL 1110-2-583 *Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures*.

In accordance with the Corps Civil Works Planning Policy, during optimization of the TSP the District will use a Habitat Suitability Index model to assess the functions and values of upland vegetation impacted and will conduct a cost analysis to determine the appropriate level of mitigation required. The specific HSI model(s) to be used will be determined during optimization. HSI models that will be considered include those for great blue heron, hairy woodpecker, downy woodpecker, and black-capped chickadee given that they are known occur within the overall project area.

For the purposes of the draft FR/EA, the District is assuming the creation of 0.70 acres of upland forest habitat. The specific location of the replanting efforts will also be determined during optimization and the District will coordinate with Middlesex County and NJDEP Green Acres Program staff to determine if there are locations within Joseph Medwick Memorial Park that would benefit from forest creation and/or enhancement. Per Corps and New Jersey policies, shrub and tree species native to New Jersey will be replanted. In addition, the District will use tree stock ranging in 8- 14 ft in height in lieu of saplings to reduce the amount of time it takes for the replacement trees to reach maturity.

The levee is located outside of the 50 ft riparian zone as regulated by the New Jersey Flood Hazard Area Control Act. Therefore, no adverse impacts to riparian vegetation will occur as a result of project implementation.

In regards to nonstructural measures, any clearing of vegetation to implement the nonstructural measures will be limited to what is necessary to construct the specific measure. Therefore, any vegetation immediately adjacent to the structure receiving non-structural treatments may need to be removed. This impact is expected to be negligible and no mitigation is proposed.

Mitigation

To compensate for the permanent loss of the 0.70 acres of uplands described above, the District is proposing to conduct on-site restoration of upland vegetation. Refer to Appendix A.9 for full description of the mitigation.

Monitoring and Adaptive Management

Refer to Appendix A.9 for full description of the monitoring procedures and potential adaptive management measures that could be employed to achieve mitigation success.

6.4.2 Wetlands

The construction of the levee and the 15 ft vegetation free zone will convert the vegetation within the phragmites dominated marsh, the low marsh and the scrub shrub wetland to maintained lawn and embankment fill. The 0.40 acres of managed wetland is already comprised of a combination of maintained lawn and asphalt. Therefore, there is no impact. The District is proposing on-site mitigation that will replace the vegetation lost with native marsh and scrub shrub wetland species.

Therefore, there will be no significant adverse impacts to wetland vegetation. The nonstructural component of the TSP will not adversely impact wetland vegetation.

Mitigation

Mitigation for wetland vegetation is discussed in Section 6.3.3 Wetlands above and in Appendix A.9.

Monitoring and Adaptive Management

Refer to Appendix A.9 for full description of the monitoring procedures and potential adaptive management measures that could be employed to achieve mitigation success.

6.4.3 Invasive Plant Species Management

Within the levee project area, phragmites is the dominant invasive plant species and will require a comprehensive management plan to prevent the unintended spread of it to other locations of the levee project area and/or downstream of the project area during construction.

The comprehensive management plan will be developed during the PED Phase and will outline measures to be taken immediately before, during and after construction. Types of measures that will be assessed include a) herbicide applications followed by mowing and/or excavation of phragmites before initiating construction; b) implementing proper disposal techniques such as bagging waste containing phragmites plant parts; c) inspection and removal of any phragmites plant parts on equipment to prevent the accidental dispersal of it to other construction sites.

The non-federal sponsor is ultimately responsible for the long term management of the mitigation site to assure its success once the District has determined that the mitigation site has achieved the mitigation objectives and concludes its involvement with the site. During the PED Phase, the District will work with the non-federal sponsor to identify potential local environmental groups that could assist the non-federal sponsor in continuing any necessary monitoring and management of invasive plant species.

During the post construction monitoring period of the open water and wetland mitigation, it is assumed there will also be adaptive management actions such as herbicide applications occurring to ensure success of the mitigation.

6.5 Aquatic Resources and Wildlife

6.5.1 Fish

Fish species that would be most impacted by the construction of the levee and open water and marsh wetland restoration would be alewife, American eel, bluefish, mummichog, and striped bass due to the fact that they inhabit tidal creeks and marsh habitat for some or all of their life cycle.

During construction of the levee and open water and marsh wetland mitigation, any juvenile or adult fish within the project area are expected to be mobile enough to leave the area. Erosion and sediment control best management practices will be employed during construction to reduce construction. However, there may be a minor increase in turbidity and sedimentation would be generated by the proposed construction activities. The turbidity could hinder predation efficiency of sight feeding fish within the creek.

An in-water work restriction from 1 May through 30 June. However, there may be a loss of any egg deposits or larvae that may be present in the construction area in the months prior to the in water work restriction window.

In addition, there may be a very localized loss of aquatic macroinvertebrate species within the immediate area of the construction site resulting from excavation associated with levee and mitigation construction that may diminish a food source for fish until the aquatic macroinvertebrates recolonize the new channel and marsh areas. Given the close proximity of the Rahway River to Casey's Creek, fish will more than likely utilize that river and other tidal tributaries within the vicinity of the project.

Because the levee and marsh restoration will be occurring within the upper portions of the wetland complex, fishery resources within the Rahway River are not expected to experience any significant temporary and/or permanent adverse impacts.

The implementation of non-structural measures within the project area will not adversely impact fish species.

Mitigation

The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively impact fish species and their habitat. In addition, an in-water work restriction from 1 May through 30 June as per the NJDEP Flood Hazard Area Control Act Rules will be implemented during construction to protect any spawning fish species. The proposed wetland and open water mitigation will enhance foraging, resting and spawning habitat for fishery resources.

Monitoring and Adaptive Management

No specific monitoring plan will be developed for fish. However, any species observed during the open water and wetland mitigation monitoring investigations may be documented.\

6.5.2 Essential Fish Habitat

Information documenting regarding the use of the Rahway River by smooth dogfish, summer flounder and inshore longfin squid is lacking. However, juvenile, and to a lesser extent, adult, smooth dogfish are known to utilize tidal marshes. In addition, juvenile summer flounder are known to utilize tidal marshes. Therefore, it is presumed that they inhabit the Rahway River for the purposes of the environmental assessment. Effects to these species is similar to what is described in Section 6.5.1.

Based on a review of the life history and habitat requirements for inshore longfin squid is not expected to occur within the project area. Therefore, there are no significant adverse temporary and/or permanent impacts to this species.

A Feasibility level Essential Fish Habitat Assessment has been prepared and is located in Appendix A.5. The Draft FR/EA and appendices, including Appedix A.9 will be submitted to NOAA-Fisheries.

Mitigation
Mitigation measures for EFH species are the same as discussed in Section 6.5.1

Monitoring and Adaptive Management
No specific monitoring plan will be developed for EFH species. However, any species observed during the open water and wetland mitigation monitoring investigations may be documented.

6.5.3 Benthic Resources

Construction of the levee and wetland mitigation could cause the direct mortality of aquatic macroinvertebrates that are not mobile enough to leave the area. Temporary increases in turbidity and suspended sediments near and downstream of the construction activities could cause direct mortality or indirect decreased reproductive success in benthic species over the short-term.

Recolonization of the wetland restoration area is expected after construction. The wetland restoration will aim to restore/enhance aquatic habitat for benthic resources.

Because the levee and marsh restoration will be occurring within the upper portions of the wetland complex, benthic resources within the Rahway River are not expected to experience any significant temporary and/or permanent adverse impacts.

Implementation of non-structural measures within the project area will not have any adverse impacts on benthic resources.

Mitigation
The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively impact benthic resources and their habitat. In addition, the in-water work restriction from 1 May through 30 June required by the NJDEP to protect fishery resources will provide similar protection to any benthic resources that also spawn during this timeframe. The proposed wetland and open water mitigation will enhance foraging, resting and spawning habitat for fishery resources.

Monitoring and Adaptive Management
No specific monitoring plan will be developed for benthic resources. However, any species observed during the open water and wetland mitigation monitoring investigations may be documented.

6.5.4 Birds

The construction of the TSP and associated mitigation will create short-term minor adverse impacts to migratory bird species are expected from the clearing of vegetation as well as noise with construction activities. However, since bird species are highly mobile, they are expected to move away from the project area during construction. Furthermore, outside the breeding season these species do not permanently remain in any one location. Implementation of vegetation clearing restrictions will benefit ground and tree-dwelling migratory birds during the breeding season. Therefore, adverse impacts to migratory bird species are expected to be short term and minor, limited to the period of construction. Following construction, bird species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area.

Mitigation

In order to comply with the Migratory Bird Treaty Act, a clearing restriction of shrubs and trees from 1 April through 31 August will be implemented during to avoid adverse impacts to any potential nesting birds that are covered under this act. The proposed upland and wetland mitigation will benefit birds by restoring or enhancing foraging, shelter and nesting habitat will be restored through the re-establishment of native herbaceous, shrub and tree species.

Monitoring and Adaptive Management

No specific monitoring plan will be developed for birds. However, bird species observed during mitigation monitoring investigations may be documented.

6.5.5 Mammals

Construction activities associated with the TSP will result in the temporary disturbance of habitat (e.g., vegetation and tree removal). Construction activities also may cause the temporary displacement of these species due to increased human activity and habitat alterations. Shrub and tree-cutting restrictions implemented to protect migratory bird species will provide some protection for tree-dwelling mammal species.

Following construction, mammals are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area. Given that the levee and nonstructural measures are located within developed areas already, the long-term impacts on local mammal populations will be minor.

Mitigation

The re-establishment of upland, riparian and wetland vegetation as described in sections 6.3.3 Wetlands and 6.4.1 Uplands and Riparian Corridor will provide foraging and cover habitat supportive of wildlife.

Monitoring

No specific monitoring plan will be developed for mammals. However, species observed during mitigation monitoring investigations may be documented.

6.5.6 Reptiles and Amphibians

The use of the area located within the footprint of the levee by reptilian and amphibian species is not well documented. Construction activities to replace the levee and mitigation may cause mortality of individuals or less mobile species that reside in the project area. More mobile species will be temporarily displaced from the area and are expected to relocate to other, undisturbed locations of the project area. Following construction, reptile and amphibian species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area.

Long-term impacts from the levee include effects on movement patterns of some amphibians and reptiles, and loss or modification of habitat. However, given that the levee is located in a developed area, the impacts will be minor.

Implementation of non-structural measures within the project area will not have significant adverse temporary or permanent impacts on amphibian or reptile species.

Mitigation

The re-establishment of upland, riparian and wetland vegetation as described in Sections 6.3 and 6.4.1 will provide foraging and cover habitat supportive of reptiles and amphibians.

Monitoring and Adaptive Management

No specific monitoring plan will be developed for reptile and amphibian species. However, species observed during mitigation field surveys may be documented.

6.6 Threatened and Endangered Species

6.6.1 Federal, Threatened and Special Concern Species

USFWS Trust Species

There will be no temporary or permanent adverse impacts to Indiana bat and/or northern long-eared bat. As described in Section 3.6.1 Federal Endangered, Threatened and Special Concern Species, preferred Indiana bat and northern long-eared bat summer roosting and foraging habitat does not include tidal wetlands. This is further supported that based on a review of the USFWS' Information Planning and Conservation website, the potential occurrence of Indiana bat and northern long-eared bat was noted only for the northern portion of the overall project area.

There are nonstructural measures proposed in the northern portion of the project area. Although any tree clearing will be minimal, a tree clearing restriction from 1 April through 30 September will be implemented during construction to minimize any adverse impacts to these species during construction. Pending coordination with the USFWS, this tree clearing restriction may also be expanded to include the construction of the levee. Implementation of the tree clearing restriction during construction is a standard operating procedure in this region and does not require the preparation of a biological assessment and formal consultation with the USFWS.

Given that two active bald eagle nests are located within two miles of the project area and the documented sightings of bald eagle at the Hawk Rise Sanctuary directly across the river from the location of the proposed levee, it is presumed that the Rahway River and wetland complexes are used as foraging habitat. The noise and overall activity occurring during the construction of the levee may deter use of this area for foraging by bald eagle. The level of impact, however, is negligible as there are other segments of the river and larger tidal wetland complexes north and south of the levee project that can be used as alternate foraging locations. The proposed wetland restoration to compensate for the permanent wetland impacts related to the levee construction will serve to enhance foraging habitat.

NOAA-NMFS Trust Species

Surveys conducted by the NJDEP and the District within the Rahway River, as discussed in Section 3.5.1, did not identify the presence of shortnose sturgeon or Atlantic sturgeon. In addition, the District conducted finfish surveys in 2006, 2011, 2013, and 2014 within the Arthur Kill as part of the New York/New Jersey Harbor Deepening (USACE, October 2104)(USACE, November 2013)(USACE, January 2013)(USACE, September 2007). One of the sampling stations

established for the surveys was located within the Arthur Kill near the confluence of the Rahway River. Based on the results of the surveys, no sturgeon were collected at either the sampling station near the Rahway River or at other sampling stations within the Arthur Kill.

Therefore, it is the District's position that neither Atlantic sturgeon nor shortnose sturgeon occur within the project area and that implementation of the TSP will have no effect on these species or their critical habitat. A No Effect Determination has been developed and is located in Appendix A.1. Formal consultation with NOAA-NMFS will not be required.

Mitigation

A tree clearing restriction extending from 1 April through 30 September will be implemented during construction to protect the Indiana bat and northern long eared bat. Alternatively, if clearing must occur within this timeframe, a presence/absence survey will be conducted prior to construction with results coordinated with USFWS. A preference to tree species that provide roosting habitat for Indiana bat and northern long eared bat will be given during development of mitigation plans.

Adherence to the 1 March through 31 August tree and shrub clearing restriction during will protect any bald eagles within project area. In addition, the District will continue to coordinate with the USFWS to determine if recommendations for avoiding disturbance at foraging areas and communal roost sites as outlined in the National Bald Eagle Management Guidelines will be required during construction.

The re-establishment of native vegetation within the project area and mitigation sites will restore bald eagle habitat.

As no NOAA-NMFS Trust Species occur within the project area, no mitigation measures are proposed.

Monitoring

No post construction monitoring will be conducted for Indiana bat and/or northern long-eared bat. No specific post construction monitoring plans for bald eagle will be developed although any observations of this species during mitigation monitoring field surveys may be documented.

6.6.2 State Endangered, Threatened and Special Concern Species

As state endangered, threatened and special concern species known to occur in the project area are bird species, the impacts associated with the project are similar to what was discussed in section 6.5.4 Birds.

Mitigation

Compliance with the Migratory Bird Treaty Act, shrub and tree clearing from 1 April through 31 August will minimize adverse impacts to state endangered, threatened and special concern species. The re-establishment of upland and wetland habitats as described in sections 6.4.1 and 6.4.2 will provide foraging and cover habitat supportive of wildlife.

Monitoring

No specific monitoring plan will be developed for state endangered, threatened or special concern species. However, bird species observed during mitigation monitoring field surveys may be documented.

6.7 Socioeconomics

The proposed action is not expected to adversely impact the socioeconomic environment of the area. During construction of the levee and floodwall, some of the property owners within the project area may be unable to fully utilize their property. Additionally, they may be required to move or dissemble structures such as sheds and above ground swimming pools to accommodate construction. Permanent easements will be required for maintenance, inspection and operational requirements. However, property owners will be compensated for the easement at its market value for the effect on the property.

Long term benefits achieved by the project include flood risk management benefits such as reduced damage to property, protection of business and residential structures, improved public health and safety, reduced traffic delays and emergency access for the fire department, medical personnel and police protection.

6.8 Environmental Justice

As discussed in Section 3.7.2 Environmental Justice, Environmental Justice considerations are applicable to the Cities of Rahway and Linden, the Borough of Carteret and the Township of Woodbridge of

The location of the levee is sited to maximize management of coastal storm risk to the community, with adjacent structures receiving the most coastal storm risk management benefits.

Participation in the nonstructural measures is in all cases voluntary and serves as a measure to reduce the risk of loss of life and property damage due to flooding. Property owners who opt to receive nonstructural measures will be compensated at the fair market cost for the construction of the measures.

Therefore, no adverse impacts to environmental justice considerations is expected.

6.9 Hazardous Toxic and Radioactive Waste

Based upon the review of the existing databases, none of the sites on the KCS list or the Superfund site are located within or adjacent to the footprint of Levee Segment D. In addition, the proposed elevations, ring walls and flood-proofing activities should not impact any of the known contaminated sites. The remediation undertaken as part of the reconstruction and upgrade to the Joseph Medwick Medwick Memorial Park would have removed the contamination from the site. As a result, the construction of this project would not have an impact on HTRW within the park.

According to Corps policy, no elevation or flood-proofing can occur to structures with asbestos and/or asbestos-containing materials if the proposed actions may affect the asbestos and/or asbestos-containing material. Prior to any actions being conducted, the asbestos and/or asbestos containing material that may be disturbed by the elevation or flood-proofing activity must be

removed. For all structures proposed for non-structural activities, an asbestos investigation will be conducted to confirm the presence/absence of damaged or friable asbestos or asbestos-containing materials. If damaged or friable asbestos or asbestos-containing materials are confirmed on a property and have been determined will be impacted by the implementation of non-structural measures, the property owner will be obligated, at his/her sole cost and expense, to conduct all necessary response and remedial activities in compliance with all applicable local, state, and federal laws and regulations. Asbestos and asbestos-containing materials that would not be affected by construction of the recommended non-structural element(s) would not need to be removed prior to construction.

This determination is based on databases of reported sites. It may be possible that unknown and unreported sites may be identified as part of construction activities. Geotechnical investigations and soil testing will be conducted prior to any construction activities associated with Levee Segment D or the non-structural elements, as necessary.

6.10 Cultural Resources

Section 106 of the National Preservation Act of 1966 (NHPA), as amended, requires that all federal agencies consider the potential effects of proposed undertakings on historic properties. The Area of Potential Effect (APE) is the geographic extent to which an undertaking may directly or indirectly cause changes in the character or use of historic properties (NHPA, 36 CFR 800.16[d]).

The APE for the TSP is broadly defined at this time based on the current level of the design. Because the plan is in an early phase of development the number of structures receiving nonstructural treatment and the size of the levee has not been finalized and is likely to change as the plan is further developed. The APE is currently defined, therefore, as the 136 structures receiving non-structural measures and their immediate vicinity, the proposed levee segment , and all staging, easement, and mitigation areas which are to be determined during the next phase of the project, the Project Engineering and Design (PED) phase.

6.10.1 Nonstructural Measures

Elevations and floodproofing of structures has the potential to cause adverse effects to the structures as well as to associated outbuildings and archaeological sites that may exist within the APE. Impacts to historic districts are also possible should the non-structural measures result in the loss of contributing resources or alter the historic character of a neighborhood.

There are no documented archaeological sites within the APE for the non-structural measures associated with the proposed undertaking. Three historic districts are identified within or adjacent to the APE for non-structural measures. These are the Rahway River Parkway Historic District, the Union County Parks System Historic District and the Upper Rahway Historic Districts. Of the structures identified for treatments, eighteen have been documented as part of the Upper Rahway Historic District. Certain structures identified for nonstructural measures are located within a short distance from the district boundaries in what is potentially part of the historic viewshed of the Rahway River Parkway and Union County Parks System Historic Districts. The Rahway River Parkway is contained within the boundaries of the Union County Parks System Historic District. Certain structures identified for nonstructural measures are located within a short distance of the

Rahway River Parkway and Union County Parks System Historic Districts. The structures located along River Road, West Grand Avenue, and Irving Street are most likely to lie within the viewshed.

Additional structures identified for nonstructural measures may also be eligible for the National Register of Historic Places but have not been subject to architectural survey. Many of the documented historic structures were last evaluated in the 1980's and should be evaluated again to determine whether they have retained their qualifying characteristics or have been significantly altered or demolished in the intervening time resulting in a loss of integrity. The Upper Rahway Historic District and the Rahway River Parkway Historic District should be re-evaluated as well to determine the status of their contributing resources and to better define their physical and viewshed boundaries within the APE.

6.10.2 Levee

Construction of the levee is likely to cause adverse effects to the Inch Lines Linear Multistate Historic District as well as to potentially deeply-buried archaeological sites. The pipeline, which is underground, is a contributing element to the district. There are no archaeological sites or additional historic properties documented within the APE for the levee. Development of Joseph Medwick Park is likely to have significantly disturbed historic and prehistoric deposits if they exist within the limits of disturbance within those portions of the APE, however, there remains the potential for deeply buried prehistoric archaeological sites as well as moderate potential for historic archaeological sites to exist.

The full extent of adverse effects is not known at this time. Most of the APE has not been subject to archaeological and architectural survey. Future surveys will help to identify previously undocumented historic properties and archaeological sites and will be critical in determining the extent of the adverse effects to the Inch Lines Linear Multistate Historic District.

6.10.3 Future Section 106 Compliance

Further refinement of the APE will occur as the plan is optimized. When a more detailed design is prepared additional architectural and archaeological investigations will be necessary to complete identification of significant resources in the APE. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended and its implementing regulations, 36 CFR 800, a draft Programmatic Agreement (PA) has been prepared that will serve as a binding agreement between the NJHPO and the District that outlines the activities and tasks that must be carried out to conclude identification of significant resources, determine adverse effects, and mitigate for those adverse effects. These activities include carrying out additional archaeological and architectural investigations based on the locations of project elements, coordination and consultation with the NJHPO, interested parties and federally recognized tribes and preparation of National Register of Historic Places nomination forms. The PA also stipulates that, depending upon the results of surveys, treatment plans or standard mitigation agreements will be prepared to outline the specific mitigation measures that will be taken to address adverse effects to structures and archaeological sites that cannot be avoided. Treatment plans or mitigation agreements would include but not be limited to specialized design guidelines for historic structures to ensure that flood protection measures are consistent with the historic fabric of the buildings, the design of the project elements along the River to fit the character of the historic districts, and data recovery for archaeological sites that cannot be avoided.

6.11 Recreation

The implementation of the levee will have mostly temporary adverse impacts to recreational use of the Joseph Medwick Memorial Park. The proposed levee footprint is within the current alignment of a portion of the Medwick Park Trail. This segment of the trail will be closed off to the public during construction and will disconnect the northern end of the park from the southern end of the park throughout the duration of the portion of the levee within the park. Upon completion of the project, recreational uses and activities of the affected parks will resume.

Implementation of the non-structural flood risk management measures will not have any long term adverse impacts on recreation within the project area.

Mitigation

Specific mitigation measures that will be evaluated may be implemented to reduce the limited short-term and long-term effects of the TSP on recreation include:

- Installing a footpath on the top of the levee to continue the current alignment of the Medwick Trail;
- Replacing the wildlife observation deck that is partially located within the levee and vegetation free zone footprint. The District will evaluate installing ramps from the levee to allow for equipment access on both sides of the levee. As part of the evaluation, the District will assess locating at least one of the ramps near the wildlife observation deck to facilitate access to the deck by park patrons.
- Planting native herbaceous, shrubs and trees within the park after construction, which include the restoration of 4 acres of low marsh and 0.50 acres of deciduous scrub shrub wetland and mitigation of 0.40 acres of managed wetland through either restoration of 0.40 acres of low marsh or deciduous scrub shrub wetland;
- Situating construction access and staging areas away from the park facilities such as the tennis courts and athletic fields to the greatest extent practicable. This evaluation will occur during the PED Phase;
- Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians; and
- Installing signage that informs residents and others using affected recreational spaces of the proposed action's purpose and closure duration.

6.11.1 Green Acres Program

Under the Green Acres program, lands obtained or developed with Green Acres funding and lands held by a local government for recreation and conservation purposes must permanently remain in use for recreation and conservation purposes. In general, lands subject to the rules of the program cannot be disposed of or diverted unless it can be demonstrated to the State that the modification will protect or enhance the use of the area. By definition in the Green Acres Rules, land that is used for purposes other than recreation and conservation is considered a "diversion" while a "disposal" is the selling, donating, or some other form of permanent transfer of possession of parkland.

Flood/storm risk management measures such as levees are typically considered as diversions. However, flood/storm risk management projects that provide regional protection and also create

or enhance a permanent water body suitable for water dependent public recreation are exempt from the diversion designation. As part of this exemption, the flood/storm risk management project cannot have significant adverse impact on natural resources or recreational value of the affected parkland.

The Joseph Medwick Memorial Park is encumbered by Green Acres restrictions. However, the proposed levee is part of a regional coastal storm risk management project that will ultimately protect park facilities such as the tennis courts, athletic fields and playground up to the 1% coastal storm event. In addition, the mitigation measures described in Section 6.10 will minimize the permanent adverse impacts to the use of the park.

Therefore, the levee will not have significant long term adverse impacts to the park or contravene the intent of Green Acres regulations.

The nonstructural measures within the project area will not have any temporary or long term impacts to Green Acres lands.

Mitigation

Mitigation measures are discussed in Section 6.10 Recreation. The District will maintain coordination with representatives from the Green Acres Program throughout all phases of the project to ensure compliance with the Green Acres rules.

Monitoring and Adaptive Management

There are no post construction monitoring and adaptive management measure requirements associated with the mitigation of Green Acre resources.

6.12 Aesthetics and Scenic Resources

The construction the TSP will have short-term minor and long-term adverse impacts to aesthetic and scenic resources. In the short-term, the presence of construction equipment and active construction activities throughout the project area will result in minimal temporary impacts to each construction site's immediate aesthetics and scenic resources. In the long term, the levee will obscure views of the Rahway River and wetland complexes to park patrons and the eight homes that are located adjacent to the proposed levee. However, a footpath will be installed on the levee and the wildlife observation deck will be replaced to enable viewing of the river and wetlands. In addition, the aesthetics of the wetland complex will be enhanced through the proposed on-site mitigation of restoration low marsh habitat. The levee will be stabilized with grass to maintain a relatively natural appearance. Therefore, there are no significant adverse impacts to aesthetics and scenic resources.

The implementation of nonstructural measures within the project area is not expected to result in significant adverse impacts on the area's aesthetics and scenic resources.

Mitigation

Mitigation measures that will be implemented to minimize impacts to aesthetics include:

- Replanting disturbed areas outside of the 15 ft vegetation free zone associated with the floodwall/levee with native vegetation. The District will consider the use of tree stock ranging from 8-14 ft in height in lieu of saplings.
- Installation of a footpath on the levee to maintain access for viewing the river and wetland complexes.
- Stabilizing the levee with grass.

6.13 Coastal Zone Management

The TSP and associated mitigation measures are compliance with all applicable policies. A Coastal Zone Management Statement of Compliance has been prepared and is located in Appendix A.

Mitigation

There are no specific mitigation measures required for Coastal Zone Management. The mitigation measures being proposed to compensate for impacts to wetland resources, public access, recreation and infrastructure are addressed in the applicable policies within the Coastal Zone Management Compliance Statement.

Monitoring and Adaptive Management

There are no monitoring and/or adaptive management requirements associated with Coastal Zone Management.

6.14 Transportation

Traffic will likely increase on local roads as a result of the transportation of construction equipment and materials and workers commuting to the levee and nonstructural measures project areas.

The impacts on transportation will not be concentrated in any one location for extended periods of time and will relocate to other areas within the levee alignment as construction progresses. These are short term and will end once construction is completed. The downstream segment of the levee project area consists of narrow, dead-end residential roads. The use of these streets by equipment and vehicles during construction of the levees will be minimized to the greatest extent practicable for safety and logistical reasons.

Long term positive impacts resulting from the levee includes a reduction in road closures due to flooding and clean-up of any debris deposited on roads during flood events.

The implementation of the non-structural flood risk management measures in the Robinson's Branch portion of the project area will not have any long term impacts on transportation.

Mitigation

In order to minimize impacts to traffic during construction, traffic control and operations strategies that may be implemented during construction may include:

- Preparing a comprehensive Construction Traffic Management Plan. This plan will be developed by the contractor in the Construction phase and will be coordinated with the appropriate municipal and/or county officials and affected property owners as necessary;
- Routing and scheduling construction vehicles to minimize conflicts with other traffic;

- Strategically locating localized staging areas to minimize traffic impacts; and
- Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.

6.15 Air Quality

The project will produce temporary localized emission increases from the diesel powered construction equipment working onsite. The localized emission increases from the diesel-powered equipment will last only during the project's construction period and then end when the project is over, thus any potential impacts will be temporary in nature.

As stated in the Air Quality Section (Section 3.14), Middlesex and Union Counties have been designated with the following attainment status with respect to the NAAQS for criteria pollutants: 'moderate' nonattainment area for the 2008 8-hour ozone standard, maintenance for the 2006 PM2.5 standard, and Union County is in maintenance of the 1971 CO standard. The counties are part of a larger Ozone Transport Region. Ozone is controlled through the regulation of its precursor emissions, which include NOx and VOCs. VOCs are emitted at a fractional rate compared to NOx emissions. SO2 is a precursor for PM2.5. Because of these designations and since the project is a Federal Action taken by the USACE, this project triggers a General Conformity Review under 40 CFR §93.154. General Conformity ensures that Federal Actions do not have a negative impact on State Implementation Plans (SIPs). For the pollutants to be emitted as part of the project, the annual de minimis levels are: 100 tons for NOx, 50 tons for VOC, and 100 tons for CO, PM2.5, and SO2 (each pollutant separately). Projects that don't have any annual emissions exceeding these threshold levels are considered to be in conformity with the SIP.

The emissions associated with the project are estimated as part of the General Conformity Review and are summarized below, by calendar year.

Summary of Emissions

		tons			
Pollutants:	NO_x	VOC	SO_x	$PM_{2.5}$	CO
Calendar Year					
2019	17.0	0.3	0.0	0.3	2.2
2020	68.0	1.4	0.0	1.2	8.7
2021	56.7	1.2	0.0	1.0	7.3

The Project's General Conformity-related annual emissions are significantly below all of the de minimis levels. Therefore, by rule (40 CFR §93.153 (b)), the Project is considered de minimis and will have only a temporary impact around the construction activities with no long-term impacts and no negative effects on the applicable SIP. Documentation of the emissions calculations is included in Appendix A.7.

Mitigation

Because the impact on air quality will be less than significant, no mitigation measures will be required outside of existing air quality regulations. NJDEP outlines requirements applicable to

construction, such as controlling fugitive dust and open burning. All persons responsible for any operation, process, handling, transportation, or storage facility that could result in fugitive dust will take reasonable precautions to prevent such dust from becoming airborne. Reasonable precautions and best management practices (BMPs) might include using water to control dust from the dam reconstruction and land clearing associated with the dam reconstruction and channel modifications. In addition, construction will be performed in full compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34), with compliant practices and/or products. These requirements include the following:

- Control and Open Prohibition of Burning (N.J.A.C. 7:27-2.3B)
- Control and Prohibition of Air Pollution from Diesel-powered Motor Vehicles (N.J.A.C. 7:27-14.15)

This listing is not all-inclusive; the USACE and contractors will use BMPs during construction and comply with all applicable air pollution control regulations.

6.15.1 Green House Gases and Climate Change

There will be no ongoing sources of Green House Gas emissions resulting from the proposed action once construction is completed. All construction activities combined will generate approximately 7,744 tons of CO2, which is below the CEQ threshold of 25,000 metric tons. Therefore, these effects are negligible.

Approximately five acres of mature deciduous upland and wetland vegetation will be removed in in project area as a result of levee construction. Through mitigation, the vegetation, will be replaced. It is anticipated that minor, short term impacts to carbon sequestration and temperature reduction will occur until the trees achieve a larger size.

6.16 Noise

The implementation of the proposed action will result in an increase in short-term minor adverse impacts related to noise. The specific impact of construction activities on the nearby receptors will vary depending on the type, number, and loudness of equipment in use. Excavators and other heavy equipment, truck removal of excavated material, and the delivery of riprap and concrete to workspaces will be the primary sources of noise. Individual pieces of heavy equipment typically generate noise levels of 80–90 dBA at a distance of 50 ft (15 m). With multiple items of equipment operating concurrently, noise levels can be relatively high during daytime periods at locations within several hundred feet of active construction sites. The zone of relatively high noise levels typically extends to distances of 400–800 ft (122–244 m) from the site of major equipment operations. Locations more than 800 ft (244 m) from construction sites seldom experience substantial levels (greater than 62 dBA) of noise.

Property owners within the footprint and vicinity of the nonstructural measures and within the vicinity of the levee will experience appreciable amounts of noise from heavy equipment during construction. However, given the temporary nature of proposed construction activities and the limited amount of noise that heavy equipment would generate, this impact will be minor. In addition, limited truck and worker traffic may be audible at locations along haul roads and roadways approaching the construction area. These impacts also will be negligible. Levee

construction and associated noise will not be concentrated in any one location for extended periods of time. Impacts to the noise environment will move from one area to another as construction progresses.

There will be no permanent or ongoing sources of noise from the proposed action. Noise will end with the construction phase; therefore, there will be no long-term or significant impacts on the noise environment.

Mitigation

Because the impact to the noise environment will be less than significant, no mitigation measures will be required. Construction activities will adhere to the applicable noise ordinances within the municipalities in which the construction is occurring.

6.17 Summary of Mitigation

The various mitigation measures being considered to avoid, minimize, reduce or compensate for the adverse environmental impacts expected from implementation of the proposed action are summarized in Table 34.

Table 34. Summary of Mitigation Measures

Land Use • Disturbed areas will be restored and their use returned to pre-construction land uses.
Soils • Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of a cofferdam or temporary culvert diversion to install the levee drainage structure in Casey's Creek and to construct the levee over Casey's Creek.
Water Resources • Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of a cofferdam or temporary culvert diversion to install the levee drainage structure in Casey's Cree and to construct the levee over Casey's Creek. • Restoration of 200 linear feet of tidal creek. • Restoration of 0.14 acres of mudflat habitat. • Maintaining an open flap gate on the levee drainage structure in Casey's Creek during normal flows.

Wetlands
• Implementation of Erosion and Sediment Control BMPs including the use of wetland access/anti-tracking mats.
• Compensation of a total 5 acres of wetland habitat through:
  • Restoration of 4 acres of low marsh habitat
  • Restoration of 0.50 acres of deciduous scrub shrub wetland
  • Restoration of 0.40 acres of either deciduous scrub shrub wetland or low marsh (compensation for managed wetland impact)
• Restoration of 0.77 acres of low marsh wetland habitat subject to temporary impacts during construction.

Vegetation

- Compensation of 0.70 acres of upland forest vegetation through either 1:1 creation/restoration or forest enhancement of areas that have been damaged through herbivory.
- Use of more mature tree stock to reduce maturation time.

Aquatic Resources and Wildlife

- Tree and shrub clearing restriction from 1 April through 31 August to comply with the Migratory Bird Treaty Act
- Re-establishment of native herbaceous, shrub and tree species in disturbed areas and in mitigation sites.
- Restoration of 200 linear feet of tidal creek.
- Restoration of 0.14 acres of mudflat habitat.
- Restoration of 4 acres of low marsh wetland habitat.
- Restoration of 0.50 acres of deciduous scrub shrub habitat.
- Creation/enhancement of 0.70 acres of upland forest habitat.

Federal and State Endangered, Threatened and Special Concern Species

- Implementation of a tree clearing restriction from 1 April through 30 September to protect roosting bat species.
- Including tree species used by bats for summer roosting in mitigation plans.

Cultural Resources

- The project is expected to have an adverse impact on historic properties, however, additional investigation is required to determine what properties will be impacted. A Programmatic Agreement has been developed for the project that outlines the steps that will be taken to determine adverse effects and the appropriate mitigation measures in consultation with interested parties (see Appendix A). Some mitigation measures to be considered include HABS/HAER documentation of historic structures, archaeological data collection, replacing or providing substitute resources, monitoring during construction, and enhancement of historic districts through signage and public outreach.

Recreation

- Planting native herbaceous, shrubs and trees within the Joseph Medwick Memorial Park after construction.
- Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians
- Installing signage that informs residents and others using the effected recreational spaces of the proposed actions purpose and closure duration.
- Installing a footpath on top of the levee.
- Replacing the existing wildlife observation deck following construction of the levee.

Aesthetics and Scenic Resources

- Replanting disturbed areas with native herbaceous, shrub and tree material after construction.

Transportation

- Preparation of a Construction Traffic Management Plan.
- Routing and scheduling construction vehicles to minimize conflicts with other traffic
- Strategically locating localized staging areas to minimize traffic impacts; and

• Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.
Air Quality • Because the air emissions are below de minimis levels for NOx, VOC, PM2.5 and SO2, no specific mitigation is required. Construction will be performed in compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34).
Noise • Construction will occur within the timeframes allowed as per local noise ordinances.

Chapter 7.0 Cumulative Effects*

The Council of Environmental Quality (CEQ) defines cumulative effects as the impact on the environment, which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or individual takes the action.

The cumulative impact analysis encompasses the Rahway River Basin. As stated in previous sections of the report, the Rahway River has experienced modifications related to the development of infrastructure and water supply. In addition to the cumulative impacts associated with those disturbances, the cumulative impacts analysis evaluates the impacts associated with past, present and foreseeable future actions listed in Tables 5-7 in Chapter 1 of this report.

7.1 Land Use

The TSP will not contribute to significant adverse cumulative effects to land use. The TSP, when combined with other past, current and future flood and coastal storm risk management measures implemented in the basin will serve to protect current land uses.

7.2 Topography, Geology and Soils

The TSP will not contribute to significant adverse cumulative impacts to topography, geology and soils. The TSP and other actions within the Rahway River Basin will be required to prevent soil erosion through the preparation and implementation of an erosion and sediment control plan. In addition, any activities proposing to change the existing grade within the floodway and flood hazard area as defined by the NJ Flood Hazard Area Control Act must obtain a permit from the NJDEP and demonstrate that the action will not induce flooding to other properties. The TSP will provide a cumulative benefit of regional flood/coastal storm risk management within the Rahway River Basin when combined with changes in topography related to other past, current and future flood/coastal storm risk management projects,

7.3 Water Resources

The TSP, current and future actions as listed in Tables 5-7 will be required to protect water quality in and adjacent to water bodies through the implementation through the acquisition of water quality certifications, wetland permits that include mitigation requirements for water resource impacts, State Pollution Discharge Elimination Systems permits and implementation of erosion and sediment control BMPs. Therefore, the TSP will not contribute to adverse cumulative impacts to water resources.

7.4 Vegetation

The TSP will result in short-term minor and long-term moderate adverse impacts to upland and wetland vegetation within the project area. Short-term impacts include removal of vegetation within construction workspaces. Vegetation will be reestablished within these areas after construction to minimize short term cumulative adverse impacts. The proposed mitigation to discussed in previous sections of the report will minimize the TSPs contribution to significant adverse cumulative impacts to vegetation.

7.5 Fish and Wildlife

The TSP is expected to have minor cumulative impacts to fish and wildlife resources. The proposed upland, wetland and open water mitigation discussed in previous sections of the report will minimize significant adverse cumulative impacts. In addition, actions taken by others that effect aquatic, wetland and riparian habitat are subject to permit mitigation requirements. Any mitigation actions taken by others in conjunction with any ecosystem restoration projects could improve fish and wildlife habitat throughout the watershed.

The TSP will not have significant adverse cumulative impacts to state and/or Federal endangered, threatened and special concern species that may occur in the project area. Nor will it have a significant adverse cumulative impact to Essential Fish Habitat species.

7.6 Socioeconomics and Environmental Justice

In general, the objective of the TSP and other flood risk management measures implemented within the Rahway Watershed is to provide a long term risk reduction to loss of life and property/infrastructure damages resulting from flood events.

The TSP will have no adverse cumulative impacts on the existing demographics, economy, housing and Environmental Justice communities in the geographical region analyzed for cumulative impacts. Increasing storm and flood risk management will reduce damage to property and infrastructure within the study area; thus implementation of the TSP is expected to benefit the local economy and housing in the long term.

All of the actions considered could produce positive cumulative socioeconomic impacts within the watershed by reducing flooding, which is disruptive to socioeconomic conditions.

7.7 Hazardous, Toxic and Radioactive Waste

The TSP will not contribute to the release and/or exposure of HTRW substances. All state and federally permitted actions, including the TSP, must implement measures such as erosion and sediment BMPs and/or an environmental protection plan to manage the risk of improper release, exposure and disposal of HTRW substances.

7.8 Cultural Resources

Cumulative impacts from nonstructural measures could potentially include adverse effects to historic districts from loss of multiple contributing historic properties or archaeological sites as well as adverse effects to the Rahway River Parkway Historic District from loss of elements contributing to the District's historic viewshed. If the construction of the levee leads to a loss of contributing elements of the Inch Lines Linear Multistate Historic District and other losses along the pipeline occur cumulative impacts to the District as a whole could be realized. As part of on-going consultation with the New Jersey State Historic Preservation Office and other consulting parties mitigation efforts will look to avoid, minimize, or mitigate for those cumulative effects.

7.9 Recreation

The TSP will not contribute significantly to adverse impacts to recreation. Rather, the TSP, combined with other flood and coastal storm risk management projects conducted by the Corps and others will protect recreational facilities and publicly owned open spaces. Measures to

minimize adverse cumulative impacts to recreation include replanting disturbed areas with native herbaceous, shrub and tree material, including a footpath on top of the levee, and replacing the wildlife observation deck.

7.10 Aesthetics and Scenic Resources

Based on the location of the TSP and other actions listed in Tables 5-7, it is not anticipated that there will be significant, cumulative long-term impacts. Most impacts will be short-term effects resulting from construction activities. The timing of the implementation of the TSP and any other actions is such that it is not anticipated that construction noted actions will be concurrent.

7.11 Transportation

The TSP will not have any adverse cumulative impacts on transportation. Positive cumulative impacts resulting from the combination of the TSP and with past, actively occurring or future flood risk management actions will be the reduction in road closures and damage to transportation infrastructure due to flooding within the Rahway River watershed.

7.12 Air Quality

The TSP will not have any adverse cumulative impacts on air quality. Air emissions related to land-based construction activities are a short-term and local impact accounted for in New Jersey's State Implementation Plan (SIP). There are no operable parts of the completed project that will result in air emissions.

There will be no ongoing sources of greenhouse gas emissions resulting from the TSP once the project is completed. All construction activities combined will generate 7,744 tons of CO2, which will be below the CEQ threshold. These effects will be negligible.

Most vegetation will be replaced through onsite and offsite mitigation. It is anticipated that minor short term impacts to carbon sequestration and temperature reduction will occur until the trees achieve a larger size. In the long term replanting with younger trees may introduce a variety of ages and species that would maximize carbon reduction over time.

7.13 Noise

The TSP will introduce short-term increases in the noise environment from construction. These changes will have a negligible cumulative effect. There will be adverse cumulative impacts on the existing environment once construction is completed.

Chapter 8.0 Coordination & Compliance with Environmental Requirements

A public information meeting was held on May 2015 in order to inform regulatory agencies and the public of the feasibility study process and to solicit feedback. Meetings to discuss the preliminary coastal storm risk management alternatives have been held with staff from the New Jersey Department of Environmental Protection Bureau of Flood Control and Dam Safety. A meeting was held in March 2017 with representatives from the New Jersey Green Acres Program to discuss the TSP (Refer to Appendix A.8).

The draft integrated FR/EA is being provided to the NJDEP Office of Permit Coordination and Environmental Review to obtain written comments regarding the TSP from the agency. The Office of Permit Coordination and Environmental Review is responsible for coordinating the review of Federal NEPA documents with other NJDEP Divisions such as Green Acres, Fish and Wildlife, Land Use Regulation, Air Quality, Water Resources Management, and the Historic Preservation Office. Additional coordination meetings may be scheduled when more detailed technical information is available for agency review.

Based on coordination with the USFWS, the draft report will be utilized to prepare a draft Fish and Wildlife Coordination Act Report (FWCAR) that summarizes their fish and wildlife conservation and protection recommendations for the TSP. The draft FWCAR is currently scheduled to be submitted to the District in July 2017. Correspondence between the District and the USFWS is located in Appendix A.3.

The Draft FR/EA will be used to complete coordination with NOAA-Fisheries regarding Endangered and Species under their jurisdiction and the Essential Fish Habitat Assessment. A No Effect Determination regarding Endanagered Species is located in Appendix A.1 and the EFH Assessment is located in Appendix A.5.

Consultation has been initiated with the New Jersey State Historic Preservation Office (NJSHPO), Tribes with significant cultural heritage in the region, and local historical organizations. The District has prepared a preliminary case report and draft Programmatic Agreement (PA) in accordance with Section 106 of the National Historic Preservation Act, as amended, and the Advisory Council on Historic Preservation Guidelines for the Protection of Cultural and Historic Properties (36 CFR Part 800) to initiate identification of historic properties within the study area and to address potential adverse effects resulting from the proposed project (Appendix A.4). The PA is to be entered into minimally by the U.S. Army Corps of Engineers and the New Jersey State Historic Preservation Office. The Advisory Council on Historic Preservation, the Delaware Nation, Delaware Tribe of Indians, and the Shawnee and Eastern Shawnee Tribes of Oklahoma have been invited to review and participate in the PA as well. Additional public involvement will be conducted as part of the public review of the EA and the PA under NEPA and will serve as the District's Section 106 public coordination. The final PA will incorporate comments on the draft document, as appropriate.

Table 35. Compliance Status of Federal Laws and Executive Orders

Legislative Title U.S. Code/Other		Compliance
Clean Air Act	42 U.S.C. §§ 7401-7671g	An air quality analysis was completed for the project. Based upon the completed analysis, the emissions from the project are considered to have an insignificant impact on the regional air quality, and according to 40 CFR 93.153 (f) and (g) the proposed project is presumed to conform to the SIP. A preliminary draft Record of Non-Applicability is located in Appendix A (Environmental Documentation).
Clean Water Act	33 U.S.C. §§ 1251 et seq.	A 404(b) Evaluation is located in Appendix A (Environmental Documentation). In addition, the District will submit a Freshwater Wetlands Individual Permit and water quality certification application to NJDEP to fulfill the requirements of Section 404 of this act prior to initiating construction.
Endangered Species Act of 1973	16 U.S.C. §§ 1531 et seq.	Based on initial coordination with the U.S. Fish and Wildlife Service, the project may contain habitat supportive of Indiana bat and northern long-eared bat. Protection of these species typically involves implementing a tree clearing restriction from 15 April – 30 September. The District will continue coordination with the USFWS throughout the life of the project. A biological assessment/formal consultation is not required. No endangered species under the jurisdiction of NOAA-Fisheries occur within the project area. A No Effect Determination is located in Appendix A (Environmental Documentation).
Fish and Wildlife Coordination Act	16 U.S.C. § 661 et seq.	The Corps is in continued coordination with the U.S. Fish and Wildlife Service. The USFWS will be preparing a Draft Fish and Wildlife Coordination Act Report. Pertinent correspondence between the District and the USFWS located in Appendix A (Environmental Documentation).
Magnuson Stevens Fishery Conservation and Management Act	38 U.S.C. § 1801 et seq.	An Essential Fish Habitat Assessment has been prepared and is included in Appendix A (Environemental Documentation). The Draft FR/EA and the EFH Assessment will be used as the coordination vehicle with NOAA-Fisheries.
National Environmental Policy Act of 1969	42 U.S.C. §§ 4321-4347	The circulation of the draft integrated Feasibility Report/EA fulfills requirements of this act.
National Historic Preservation Act of 1966	16 U.S.C. §§ 470 et seq.	The District has continued to coordinate with the State Historic Preservation Office to fulfill requirements of this act. The draft Programmatic Agreement for the project is located in Appendix A (Environmental Documentation).
Executive Order 11990, Protection of Wetlands	May 24, 1977	Circulation of this report for public and agency review fulfills the requirements of this order.

Executive Order 11988 Floodplain Management	May 24, 1977	The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision making on projects that have potential impacts on or within the floodplain. The eight step assessment is as follows: 1. Determine if the proposed action is in the base floodplain: The proposed actions are located within the base floodplain for the Rahway River. 2. If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain: As the primary objective of the project is acquiring property for the purpose of removing structures from the continued threat of property loss, hazards to health and safety, and injury and loss of life within the Rahway River Basin, no practicable alternatives are completely outside of the base floodplain for the sites that would achieve this objective. 3. Provide public review: The proposed action was coordinated with the public, government agencies, and interested stakeholders. 4. Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values: Practicable measures and alternatives were formulated and potential impacts and benefits were evaluated in Chapter 4 of this document. The anticipated impacts associated with the TSP are summarized. 5. Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values: Implementing the TSP would have no significant flooding impacts on human health, safety, and welfare and will restore the affected properties to act as natural floodplain areas. 6. Reevaluate alternatives: No practicable alternatives are completely outside of the base floodplain for the sites that would achieve this objective. 7. Issue findings and a public explanation: The public will be advised that no practicable alternative to locating the proposed action in the floodplain exists, as indicated in Item 2 above. 8. Implement the action. The proposed project does not contribute to increased development in the floodplain and does not increase flood risk,

		but rather it restores "natural and beneficial values." This assessment concludes that all practicable alternatives have been considered, and that the Corps has determined that the proposed action does not induce direct or indirect floodplain development within the base floodplain.
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	April 21, 1997	Implementation of this project will reduce environmental health risks. Circulation of this report for public and agency review fulfills the requirements of this order.
Executive Order 13112 Invasive Species	February 3, 1999	BMPs to prevent spread, proper disposal of invasive plant species during construction, replanting with native vegetation monitoring and adaptive management such as invasive species management until mitigation is determined to be successful. Refer to section 6.4.3 for additional information.

Table 36. Compliance Status with New Jersey State Laws

Legislative Title and code/date		Compliance
Flood Hazard Area Control Act – FHACA Rules	N.J.S.A 58:16A (N.J.A.C. 7:13)	The TSP is located within the flood hazard area and will require a FHACA Individual permit. The District is in continued coordination with the NJDEP. Permits will be obtained during Preconstruction Engineering Design (PED) Phase.
Freshwater Wetlands Protection Act Freshwater Wetlands Protection Rules	N.J.S.A. 13:9B (N.J.A.C. 7:7A)	The levee is impacting 0.50 acres of deciduous scrub shrub wetland and which will require an Individual Freshwater Wetland permit. The District is in continued coordination with the NJDEP. Permits will be obtained during the PED Phase,
Waterfront Development Act - Coastal Zone Management Rules	N.J.S.A 12:5-3 (N.J.A.C. 7:7)	The TSP will require a Waterfront Development permit, an Individual Coastal Wetlands permit and a Water Quality Permit as promulgated by the CZM Rules. A statement of compliance with New Jersey's CZM policies is located in Appendix A (Environmental Documentation). The Waterfront Development permit and Individual Coastal Wetland permit will be obtained during PED Phase. A conditional Water Quality Certification or equivalent will be included in the Final Report.
New Jersey Erosion and Sediment Control Act	N.J.S.A. 4:24-39 (N.J.A.C. 2:90-1.1)	An erosion and sediment control plan will be developed during the construction phase and will be submitted to the Union-Somerset and Freehold Soil Conservation Districts for approval.
New Jersey Pollution Disharge Elimination System Permit	N.J.S.A. 58:10A-58:12A-1 (N.J.A.C. 7:14A)	The SPDES permit will be applied for by the construction contractor once the E&S Plan is approved by the Union-Somerset and Freehold Soil Conservation Districts.

Green Acres Program	N.J.S.A. 13:8 (N.J.A.C. 7:36)	A portion of the Segment D levee is located on lands acquired through Green Acres funding and will require approval from the Green Acres Program. Any required approvals/permits will be obtained in the PED Phase.

Irreversible and Irretrievable commitment of Resources

There are several resources, both natural and built, that would be expended during the construction and operation of the proposed project. These resources include the land area used for the channel modifications within the Township of Cranford and implementation of nonstructural measures in the Robinson's Branch portion of the project area. Materials used for construction; energy in the form of gas and electricity consumed during construction and routine maintenance activities; and the human effort (time and labor) required to develop construct and maintain various project components. These resources are considered irretrievably committed because their reuse for some purpose other than the project would be highly unlikely. This commitment of resources and material has been weighed against the public purpose and need for the proposed action and would provide various social, environmental and economic benefits.

Chapter 9.0 Plan Implementation

The implementation process would carry a plan that is recommended through the pre-construction engineering and design (PED) phase of a project, including development of plans and specifications, and construction. Funding by the Federal Government to support these activities would have to meet traditional civil works budgeting criteria.

9.1 Consistency with Laws and Policy

This draft feasibility report has been prepared in accordance with relevant laws and USACE policy. Specifically, this section of the report addresses:

- the specific requirements necessary to demonstrate that the project is technically feasible, economically justified and environmentally complaint;
- and the costs and cost-sharing to support a Project Partnership Agreement (PPA).

Economics Justification and Environmental Compliance. The prior sections of this draft report demonstrate that the TSP is technically feasible. It also identifies the TSP at this point in the study to have benefits greater than costs. The draft Environmental Assessment has been prepared to meet the requirements of NEPA and demonstrate that the TSP is compliant with environmental laws, regulations, and policies and has effectively addressed any environmental concerns of resource and regulatory agencies.

9.2 Cost Sharing and Non-Federal Sponsor Responsibilities

The non-Federal costs include the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD), estimated to be $2,717,219.

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65% Federal and 35% non-Federal.

Project First Cost is the constant dollar cost of the TSP at current price level and is the cost used in the authorizing document for a project. Total Project Cost is the constant dollar cost fully funded with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in Project Partnership Agreements for implementation of design and construction of a project. Total Project Cost is the cost estimate provided to non-Federal sponsors for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation. The TSP First Cost is $66,900,321 and the TSP Total Project Cost is $70,930,000.

Table 37. First Cost Apportionment Table

	Federal	Non-Federal	Total
Initial Project Cost	$43,485,209	$23,415,112	$66,900,321
Real Estate Credit		$2,717,219	
Cash Contribution		$20,697,893	

Total	$43,485,209	$23,415,112	$66,900,321

Table 38. Total Project Cost Apportionment Table

	Federal	Non-Federal	Total
Initial Project Cost	$46,104,000	$24,825,000	$70,930,000
Real Estate Credit		$2,717,219	
Cash Contribution		$22,107,781	
Total	$46,104,000	$24,825,000	$70,930,000

Operation, maintenance, repair, rehabilitation, and repair (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of annual OMRR&R requirements, estimated at $51,484/year. The Federal government is responsible for preparing and providing an OMRR&R manual to the sponsor.

9.3 Design and Construction Considerations

In order for preconstruction, engineering and design (PED) and construction to be initiated, USACE must sign a Project Partnership Agreement (PPA) with a non-Federal sponsor to cost share PED and construction. This project would require congressional authorization for PED and implementation. PED and construction are cost shared 65% Federal and 35% non-Federal. Implementation would then occur, provided that sufficient funds are appropriated to design and construct the project.

Draft Schedule. The draft schedule for plan implementation was developed for planning and cost estimating purpose. See Appendix D (Cost Engineering) for the proposed construction schedule.

Table 39. Draft TSP Implementation Schedule

Rahway River Basin, New Jersey Coastal Storm Risk Management Project	
Implementation Schedule	**Date**
Submission of Chief's Report	
Chief Signs Report	December-2018
Project Partnership Agreement (PPA)	
PPA Execution	January-2019
Pre-Construction Engineering & Design (PED)	
Prepare Plans & Specifications & Request for Proposal (Begin)	February-2019
Contract Award (Begin)	September-2019
Construction	
Construction complete	September-2021

Initial construction of the Segment D levee is estimated to take from October 2019 until September 2021. Initial construction of the nonstructural measures are estimated to take within that time frame. Construction years are assumed for the economics evaluation in this study, but are subject to future project approval and funding requirements.

9.4 Real Estate Requirements

USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. The non-Federal costs include the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD), estimated to be $2,717,219. Details are provided in Appendix E (Real Estate Plan).

9.5 Views of Non-Federal Sponsors and Other Agencies

The non-Federal sponsor, the NJDEP, has indicated their support for releasing this report for public and agency input. The non-Federal sponsor's support for the TSP will be confirmed through a Letter of Support following Public and Agency reviews.

Chapter 10.0 Local Cooperation Requirements

The non-Federal Sponsor would need to provide their support of the recommendations presented in this report and agree that they intend to execute a Project Partnership Agreement (PPA) for the Recommended Plan before the Draft Integrated Feasibility Report and Environmental Assessment can move forward to the Civil Works Review Board Milestone. A coordinated PPA package would be prepared subsequent to the approval of the Feasibility Report, which would reflect the recommendations of the report.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent of initial project costs assigned to coastal storm risk management:

(1) Provide, during design, 35 percent of design costs allocated to coastal storm risk management in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Provide all lands, easements, rights-of-way, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the initial construction or operation and maintenance of the project;

(3) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Participate in and comply with applicable Federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the coastal stomr risk management features;

d. Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal government;

e. For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

f. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

g. At least twice annually and after storm events, perform surveillance of the project area to inspect for condition and damages and provide the results of such surveillance to the Federal government;

h. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

i. Hold and save the United States free from all damages arising from the initial construction, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

j. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, operation and maintenance of the project;

l. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, or operation and maintenance of the project;

m. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all effected persons of applicable benefits, policies, and procedures in connection with said act;

p. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)); and

q. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

Chapter 11.0 Recommendations (DRAFT)

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility and compatibility of the project with the policies, desires and capabilities of the State of New Jersey and other non-Federal interests.

I recommend that the selected plan for coastal storm risk management in the Rahway River Basin, New Jersey, as fully detailed in this Integrated Feasibility Report and Environmental Assessment, be authorized for construction as a Federal project, subject to such modifications as may be prescribed by the Chief of Engineers.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified (by the Chief of Engineers) before they are transmitted to the Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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